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NOTES AND COMMENTS.

The New Scrap Order.

The Ministry of Munitions, under date of August 20, has issued, under the Defence of the Realm Act, an Order to any person or firm to sell to the Ministry, when required, any iron or steel scrap in his possession, whether in the form of metal, machinery, plant, or constructional steel. If doubt arises as to whether any piece of machinery or plant is scrap, the decision of the Controller of Salvage and Stores shall be final.

The powers taken under this Order are as wide and far-reaching as any which have yet been announced. They give the Controller power to visit a works, condemn as scrap machinery and iron and steel buildings forming part of a works; to requisition from the owner sufficient labour and tools to remove it, and if the owner fails to comply, such alleged scrap machinery and plant may be sold or transferred by the Controller, the owner receiving the price realised after deduction of the costs of removal and sale! In other words, the Ministry has power, under this Order, to force a trading company to sell all its plant as scrap; to pay for the cost of dismantling and selling its plant, and all he receives is the balance realised after its sale as scrap iron, steel, brass, or other metal. It may be that no such case will ever occur, but the powers are there.

It will be remembered that originally a Scrap Department was created at the Ministry, under the direction of Mr. Walker (a partner of Sir James Stevenson), whose praiseworthy object was to secure a steady flow of scrap for iron and steel works' use. A committee of scrap merchants was appointed in an advisory capacity, and meetings have regularly been held to discuss matters. The securing of what is known in the United States as "Farmers' Scrap"—*i.e.*, the countless scrap objects of iron and steel scattered in farms, villages, buildings, and yards throughout the country—is a difficult task, and is not made easier by the fact that the actual price realised by the original owner is greatly reduced from the control price by repeated handling and cost of collection. A further difficulty is the vast quantity of machinery and plant lying about the country not at present in use, and obsolete in character, but which may at one time or another be put into use, and is probably carried on the owners' books at considerably over scrap value. Whether or not does not matter, the potential value to the owner is there, and the munitioning of the Army in the early days was often well carried out by what some technical experts might describe as obsolete rolling mills and steel works. Apart, however, from this, under the Finance Act such realisation of old plant in the case of firms making excess profits goes largely into the Government coffers, and while there is every reason why the country's scrap should be cleared up during this war period of high prices, there is every reason why the proceeds of that process should go to its right-

ful owners. This was at last recognised, and it was announced some time ago that an Order was to be issued allowing an owner to place to a special renewal-of-plant account all sums realised from the sale of old scrap iron and steel and machinery. This would have been eminently fair; but, so far, no public announcement has been made.

Factory and Workshops Report for 1917.

The Annual Report of the new Chief Inspector of Factories and Workshops, MR. H. M. ROBINSON, recently issued, states that the reduced staff has again been very fully employed, not only in their ordinary administrative duties under the Acts, but also in special work arising out of the war. Of the latter the inquiries into and reports on the applications for emergency Orders under Section 150, with the frequent visits necessary to see that the Orders were being observed, and investigations into conditions of employment and processes with a view to the substitution of women for men have again occupied most time. They are dealt with more fully in separate reports by Mr. Bellhouse, Deputy Chief Inspector, and Miss Anderson, Principal Lady Inspector.

The enforcement of welfare conditions in factories has now become part of the ordinary duty of the staff under the Police, Factories, etc. (Miscellaneous Provisions) Act, 1916. Great attention has been paid to this subject both in connection with the proposals for Orders under that Act and in connection with the application for emergency orders, the grant of which is conditional in many cases on the provision of special welfare arrangements. The power to make Orders under the above Act has been largely made use of during the year. Conferences with employers' and workers' representatives followed to discuss criticisms and suggestions which had been submitted, and before the close of the year Orders were made requiring the provision of :—(1) Protective clothing and cloak and messroom accommodation in factories in which the manufacture of terne or tinplates is carried on. (2) A supply of drinking water in all factories and workshops in which twenty-five or more persons are employed. (3) "First-aid" boxes and, in some cases, ambulance rooms in blast furnace plants, rolling mills, and other metal works. Further Orders have been issued during the current year, and the necessary inquiries are being made for their extension to other classes of factories. Welfare supervision is also a matter that has received great attention in factories and workshops, and the importance of securing competent supervisors is increasingly recognised by occupiers.

Mr. G. Bellhouse, in his separate report, lays emphasis on the gradually increasing number of cases in which work before breakfast is being abandoned, a striking feature of the experiments made in this direction being the success attained in the way of better work and maintenance of output. Sunday labour has now been reduced to small dimensions, having been proved to be unprofitable and even harmful. While night work for protected persons is still necessary, overtime employment is much less general.

Miss Anderson, in her own report, quoting reports from her subordinates, states, among other things, that much heavy work in large steel and iron works, blast furnaces, brick works, and spelter works is done by women in the open air, and given suitable clothing and work under shelter on very wet days, it appears to be very healthy. Women coming from clothing factories found such work even in the cold winter in 1917 beneficial. In foundry work we hear of a woman driver of a heavy forge hammer performing her duties satisfactorily, of women fettlers and drillers of iron and brass castings working with success, whilst the number of women core makers is increasing. At a large steel works in South Yorkshire, where the managers were of opinion in 1916 that women would be useless to them, there are now over 300 employed to their satisfaction in light labouring and yard work.

Employment of Munition Workers After the War.

Numerous schemes for the re-employment of munition workers after the war are contained in the first interim report of the Civil War Workers' Committee of the Ministry of Reconstruction. In a prefatory note Dr. Addison states that the document is published in order to facilitate public discussion of the questions raised on it. Action is being taken in connection with some of the matters referred to, and others are under further examination by committees or otherwise. Some of the recommendations must necessarily be considered by the Government in relation to other allied questions of reconstruction, and an announcement of the Government's policy will be made in due course.

The recommendations may be summarised as follows :—

(a) Steps should be taken by the Government to assist munition and other workers discharged on the termination of hostilities to return to their former or other employment.

(b) The machinery by which this assistance should be given should be the employment exchanges working in conjunction with the Labour Resettlement Committee and the local advisory committees, which it is understood are now being constituted by the Ministry of Labour in accordance with the recommendations of the Army Demobilisation Committee.

(c) In addition, the advice of industries as a whole should, where necessary, be sought through the joint industrial councils where these exist, or in other cases through the temporary trade committees which it is understood are now being set up by the Ministry of Reconstruction, the Board of Trade, and the Ministry of Labour, acting jointly.

(d) As soon as there is a reasonable prospect of peace the local advisory committees and the employment exchanges should take steps to ascertain where workers are likely to be required immediately on the termination of the war and what the demands of individual factories are likely to be.

(e) Registration of individual war workers should be undertaken with a view to facilitating their return to their former employment or finding fresh employment for them. The details of this scheme should be worked out by the Ministry of Labour, care being taken that the assistance of trade unions shall be secured.

(f) Arrangements should be made in connection with the termination of Government contracts whereby, subject to such exceptions as may be necessary, munition workers should receive a fortnight's notice or a fortnight's wages in lieu of notice.

(g) Steps should be taken by the Departments concerned to encourage Government Departments, public or semi-public bodies, and private employers to place post-war contracts in advance, the contracts being arranged, if necessary, at provisional prices to be adjusted later according to revised estimates of the cost of labour, materials, and other things, or, as an alternative, on a profit basis. Similar measures should be taken by the Department of Overseas Trade through their trade commissioners and commercial attachés abroad.

(h) The Government should have in readiness before the end of the war further schemes to meet the possibility of any local or general unemployment which may prove to be more than of a temporary nature.

It is estimated that the number of persons engaged in munition industries (including shipbuilding) was, in October last, 2,726,000, of whom 2,022,000 were men and 704,000 women. It is, however, says the report, very unlikely that in a number of the industries now engaged on munition work, the cessation of the war will, assuming raw materials to be available, involve reduction of employment.

Influence of Some Special Constituents on Cast-Iron.*

By A. Campion, F.I.C.†

The ironfounder, in common with other producers, is now called upon to supply material in the form of castings of more or less complicated design to meet the demands of modern engineering consequent upon the uses of increased speeds, high pressures and temperatures. Cast-iron has hitherto received very much less attention as regards systematic investigation of its constitution and properties than steel and many of the non-ferrous materials.

It is to be hoped, however, that the interest which has been aroused as a result of war conditions may be sustained, and lead to a better knowledge of this most interesting metallurgical product, with the adoption of less empirical methods of foundry practice.

The principal factor governing the properties of cast-iron is the carbon condition, and practically all control of the material is through the carbon, and obtaining a suitable ratio of combined to total carbon. There is, however, even in strong iron, often some ferrite, and the properties of this may be modified by the presence of other impurities or constituents in such a way as to affect the iron as a whole.

In the case of steel much has been accomplished by alloying one or more special elements with the iron in addition to carbon; but as regards cast-iron comparatively little appears to be known as to the effect of similar additions, or, at any rate, the literature available is very meagre, and much of what does exist has reference to the results of purely laboratory experiments or to the use of special additions as "physic" to cure troubles which could and should be dealt with by other methods.

The author has for some time devoted a good deal of attention to the influence of special constituents on the chemical, physical, and mechanical properties of strong grey iron, and when the invitation to present a paper at this Conference was accepted, it was his intention to give the results of some of the investigations. Unfortunately it has been impossible to complete the work and to sufficiently consider all the results obtained in time, so that all that is now presented is a general review of the literature and a few notes indicating the main influence of some special additions to strong grey irons. The fuller results of the experiments and practical foundry trials are reserved for another occasion.

Nickel.

Keep § some years ago made experiments by adding metallic nickel to a grey machinery iron containing total carbon 3.55 per cent., graphitic carbon 3.22 per cent., combined carbon 0.33 per cent., silicon 1.25 per cent., sulphur 0.040 per cent., phosphorus 0.084 per cent., manganese 0.187 per cent. He came to the conclusion that no advantage could be expected from the addition of small quantities of this element. He gave the following results of transverse tests made on bars ½ in. square and 12 in. between supports :—

Nickel added. Per cent.	Strength. Lbs.	Deflection. Ins.
0	375	0.28
0.25	327	0.23
0.50	295	0.19
0.75	330	0.24

Guillet ‡ found that nickel assisted the precipitation of graphitic carbon, and that the pearlite disappeared as the nickel increased, cementite became more or less acicular in form, sorbite appeared and afterwards gamma iron, and on the disappearance of sorbite there formed troosto-sorbite.

Thaler † states as the result of numerous experiments that in the case of ordinary pig-iron containing about 4 per cent. carbon the addition of 1 per cent. nickel causes the separation of 50 per cent. of the carbon as graphite, and further additions to a maximum of 47.78 per cent. cause a gradual increase in the graphite until 85.71 per cent. of the total carbon is so precipitated.

The temperature of solidification is raised owing to the high melting point of nickel. The pearlite point is strongly influenced, and disappears entirely with comparatively low percentage of nickel. Microscopically the pearlite gradually disappears until finally the structure consists only of very large flakes of graphite embedded in a ground mass of ferrite.

W. H. Hatfield § also states that the precipitation of graphitic carbon is much facilitated by the presence of nickel, and that in this manner it acts as a softener, but in no other direction does the addition appear to have a useful effect. As bearing on this matter reference may be made to an interesting paper by McWilliam and Barnes ** on nickel steel, in which they show that even in hypo-entectoid steels free carbon is precipitated by severe annealing.

The author has made experiments which confirm the precipitation of graphite by nickel. A cast-iron contained 2.54 per cent. of graphitic carbon, and an addition of 1 per cent. of nickel increased the graphitic carbon to 2.77 per cent. The transverse and hardness tests gave the following results :—

Nickel added. Per cent.	Load. Lbs.	Modulus of rupture. Lbs./sq. in.	Hardness.
0	509	44,310	228
1.0	625	54,863	217

Chromium.

The influence of this element does not appear to have been much studied as regards the strength and other properties of cast-iron.

Keep ‖ at the suggestion of Sir R. A. Hadfield, made a few experiments with amounts up to 2 per cent., and as a result came to the conclusion that very little benefit resulted from the addition of chromium. The shrinkage was increased when less than 1 per cent. was added. The following are some results obtained upon a special grey iron containing 1.25 per cent. silicon and 0.187 per cent. manganese, and on ordinary cupola metal :—

Chromium Added. Per cent.	Grey iron. Strength. Lbs.	Grey iron. Deflection. Ins.	Cupola metal. Strength. Lbs.	Cupola metal. Deflection. Ins.
0	335	0.23	374	0 21
0.10	332	0.20	362	0.21
0.50	345	0.24	366	0.20
1.00	475	0.24	373	0.15
1.50	345	0.17	363	0.19
2.00	355	0.21	352	0.18

These results show that there is a slight increase in strength up to 1 per cent., and then a decrease.

Practically all the other available literature deals with the manner in which chromium affects the carbon and iron relationship. It has been conclusively shown

* Read before the British Foundrymen's Association Conference at Sheffield, June, 1918.

† Professor of Metallurgy, Royal Technical College, Glasgow.

§ Cast-Iron, 1916, p. 212.

‡ Comptes Rendus, cxlv., pp. 552-553.

† Giesserei Zeitung, ix, pp. 73-75, 172-174; Journal Iron and Steel Institute, 1912, ii., p. 583.

§ Cast-Iron in Light of Modern Research, 1912, p.100.

** Journal Iron and Steel Institute, 1911, i., p. 269.

‖ Cast-Iron, 1906, p. 213.

by Arnold and others that a double carbide of iron and chromium is formed, and that even the pearlitic cementite contains that element, whilst some of it may go into solution in the ferrite. The only reliable data as to the effect of chromium upon iron is the work of Arnold and Read *, but the experiments were all with steel, and not cast-iron.

It is known that the presence of appreciable quantities of chromium in iron for malleable castings retards or even prevents successful annealing. This is as might be expected, owing to the greater stability of the carbide.

W. H. Hatfield † states "the action of the chromium is probably two-fold—

(1) By crystallising with the carbide it renders the carbon more stable, acting in this manner similarly to vanadium. The addition of chromium, therefore, tends to harden cast-iron, and will be found to increase the chill. Graphite separates with increasing difficulty as the percentage of the element under discussion increases.

(2) It is most probable that the chromium remaining in the ferrite definitely modifies the characteristics of that constituent; and since, after all, ferrite frequently constitutes the matrix of cast-irons, this phase is worth considering."

The present author's results in general bear out the above statements, as shown by the following carbon results :—

	Total carbon	Graphitic.	Combined.
Without chromium ...	3.371	2.540	0.831
1 per cent. chromium added	3.431	2.337	1.094

Transverse and hardness results were :—

Chromium added. Per cent.	Load. Lbs.	Modulus of rupture Lbs./sq. in.	Hardness.
0	509	44,310	228
1.0	573	50,640	230

Molybdenum.

The author has been unable to discover any literature relating to the effects of making additions of this element to cast-iron, although a considerable amount has been published in regard to steel.

Arnold and Read § carried out an exhaustive series of investigations as to the iron-carbon-molybdenum relations, on lines similar to those pursued in the case of chromium, nickel, tungsten, and cobalt. They found that with 18.25 per cent. of molybdenum free carbide of iron disappears, and a double carbide of iron and molybdenum obtains corresponding to the empirical formula Fe^3Mo^3C. This double carbide shows considerable chemical stability. Molybdenum reduces the ductility and ability to withstand alternating stresses. High molybdenum appears to cause segregation of the double carbide.

Lautach and Tamman ** determined the temperature concentration diagram for alloys containing 0.70 per cent. of molybdenum, and found that a compound which does not attain equilibrium is formed at 42.5 per cent. They did not determine the formula, but state that its presence is well marked at 2,300 deg. C., and that it behaves like a ternary system of iron, molybdenum, and another element.

E. Vigouroux ‡ also investigated the iron-molybdenum system, and obtained four definite compounds corresponding to the formulæ Fe^2Mo, Fe^3Mo^2, $FeMo$, $FeMo^2$. They were all very hard and brittle, and showed magnetic properties.

It has been reported that experiments have recently been carried out in America, for the purpose of determining the influence of molybdenum additions to cast-iron, but the writer has been unable to trace publication or obtain verification of the results.

The author has made a number of experiments in this direction, and the results indicate an increase in strength and reduction in the Brinell numeral, as shown below :—

Molybdenum added. Per cent.	Load. Lbs.	Modulus of rupture. Lbs./sq. in.	Hardness.
)	509	44,310	228
.0	680	65,550	217

The total carbon in the molybdenum alloy was 3.353 per cent., made up of graphite carbon 2.374, and combined carbon 0.979 per cent.

Tungsten.

Although a considerable amount of work has been accomplished in investigating the influence of additions of this element to cast-iron, very little has been published, and much of the published work is unreliable. Here, again, the investigations of Arnold and Read * have a possible bearing. They found that tungsten acted similarly to vanadium, although in a lesser degree. It forms no double carbide, and the carbide of tungsten entirely displaces the carbide of iron when about 11 per cent. is added. High tungsten assists the segregation of the carbide of tungsten. A tungstide of iron is formed which is a hard and stable body.

O. Ruff and R. Wunsch † found that tungsten forms two and probably three carbides—(1) W^2C with a melting point above 2,700 deg. C.; (2) WC., which decomposes on heating; and (3) probably W^2C. They also observed three entectics, the first containing 1.4 per cent. carbon and melting at 2,690 deg. C., the second containing 2.4 per cent. carbon melting at 2,660 deg. C., probably metastable, and the third containing 3.5 per cent. carbon melting at 2,580 deg. C.

The results of a number of experiments which have been communicated to the author by reliable workers indicate that additions of less than 1 per cent. of tungsten exert comparatively small influence upon grey cast-irons, but from 1 to 2 per cent. lead to a very considerable accession of strength, both tensile and transverse. The carbide is rendered very much more stable, and the material becomes more suited for high-temperature work.

An indication of the general effect of tungsten is shown by the following results:—An iron containing about 1.5 per cent. silicon, 0.5 per cent. manganese, combined 0.65 per cent., and graphitic carbon 2.70 per cent. gave a tensile test of 11.8 tons per square inch. An addition of 1.2 per cent. tungsten to this iron caused the tensile strength to rise to 17.9 tons per square inch.

In another case the result was 20.8 tons per square inch with 1.28 per cent. tungsten, against 13.4 tons in the plain material.

The following are results obtained recently by the author :—

Tungsten added. Per cent.	Load. Lbs.	Modulus of rupture. Lbs./sq. in.	Hardness.
0	509	44,310	228
1.0	657	59,370	209

Boron.

Although many years ago attempts were made to introduce boron into steel, it is only within very recent years any satisfactory results have been obtained. At the Electro-Chemical Works, Bitterfield, § some experiments were carried out to determine the effect of making additions of this element to cast-iron. The general effect is stated to be a great increase in hardness and brittleness. Alloys containing 0.2, 0.4, and 0.8 per cent. boron were prepared, that containing

* The Chemical and Mechanical Relations of Iron, Chromium and Carbon, Journal Iron and Steel Inst., 1911, i., p. 249.
† Cast-iron in Light of Recent Research, 1912, p. 96.
§ Chemical and Mechanical Relations of Iron, Molybdenum and Carbon, Proc. Inst. Mech. Engineers, 1915, pp. 629-651.
** Zeitschrift fur Anorganische Chemie, vol. lv., pp. 386-401.
‡ Comptes Rendus, cxiii., pp. 889-891 and 928-930.

* Chemical and Mechanical Relations of Iron, Tungsten, and Carbon, Inst. Mech., Eng., 1914, and Engineering, xcvii., p. 433.
† Zeitschrift fur Anorganische Chemie, lxxxv., p. 292-293.
§ Stahl and Eisen, 1914, xxxiv., p. 1,530.

0.4 per cent. was too hard to be machined with ordinary tools, whilst the 0.8 per cent. alloy was so brittle that it could be powdered in a mortar.

The structure was entirely changed, and the fracture was white. It is further stated that the formation of graphite is prevented and stability of the carbide increased. Unfortunately the details of the experiments are not fully stated, and the composition of the original iron is not given. It has been shown that a compound Fe^5Bo^2 is formed in ferro-boron alloys.

N. Tschichewsky and A. Herdt * investigated the properties of alloys of iron and boron, and have described an equilibrium diagram. Microscopic examination showed that even with as little as 0.08 per cent. boron a pearlitic constituent is found (sodium picrate etching) which is described as boro-pearlite. The alloys in close proximity to the eutectic ratio show ferrite in fir-tree-like crystals. The eutectic contains 3.1 per cent. boron, and with higher percentages free boride of iron is found in beautiful crystals. The brittleness of the alloys increases with rising boron, and with 8.5 per cent. the material can be crumbled in the fingers, but above 9.2 per cent. the mechanical properties improve.

The author has made a number of experiments in this direction, but the results obtained do not indicate the excessive hardness and brittleness which might be expected from the work of Tschichewsky and Herdt, either in steel or cast-iron, with percentages up to 4.0 per cent. The materials could in all cases be quite easily worked and machined, and ferro-borons up to 35 per cent. boron do not show brittleness, although hard.

The following results show the effect of this element on cast-iron :—

Boron added. Per cent.	Load. Lbs.	Modulus of rupture. Lbs./sq. in.	Hardness.
0	509	44,310	228
1.0	638	60,230	214

Vanadium.

This element confers such remarkable properties upon steel that it is not surprising that many workers have been led to look for similar results with cast-iron. The literature of the subject is fairly extensive, but much of the published work is contradictory.

In 1907 Dr. Moldenke † described results of experiments with small additions of vanadium to cupola metal. He obtained the following results with grey iron, the tests being made upon the American Society for Testing Materials' standard bar :—

Vanadium added.	Breaking load. Lbs.	Deflection. Ins.	Modulus of rupture. Lbs./sq. in.
0.0	1,980	0.105	38,680
0.27	2,360	0.100	46,070
0.33	1,980	0.100	38,700
0.36	2,372	0.090	46,320

These results are inconclusive, and show no apparent connection between the vanadium added and the strength. Results of similar experiments with white irons were equally unsatisfactory. Unfortunately no particulars were stated as to amount or conditions of the carbon, or the manner of casting.

As the result of experiments carried out by C. J. Mesta, the Mesta Machine Company, Pittsburg, took up the manufacture of vanadium iron castings with considerable success. Kent Smith, § one of the earliest workers with vanadium, regards this element as a tonic to improve already good metal, but not to make bad metal good. He states that the principal action is as a scavenging agent for removing oxygen, by decomposing and diffusing any suboxide present in the metal. (This, however, is disputed by Hatfield and others, who doubt the existence of oxygen in cast iron). Kent Smith also claims that vanadium removes nitrogen, and concludes that in scavenging a softening agent is removed and the cast-iron is toughened. He also states that the vanadium iron pours better, it causes all the constituents of the carbides to be more compact, and the vanadium in solid solution prevents passage of carbide through the ferrite. He recommends as a general rule the addition of 0.15 per cent. of the element.

The following results are given by him as representative :—

Tensile Strength. Tons/Sq. In. Vanadium added.	With vanadium.	Without vanadium.
0.20	14.25	10.7
0.15 (cupola)	16.50	11.6
0.15 (air furnace)	14.70	13.4
Not stated.	8.70	5.5

Transverse Tests.	Lbs.	Lbs.
0.15 (cupola)	2,200	1,300
0.15 ,,	1,900	1,400
0.15 ,,	3,400	2,500
0.15 (air furnace)	4,200	3,700
0.13 ,,	4,400	4,000

Compression Tests.	Tons.	Tons.
0 15	67	60.0
0.15	71.5	65.2
0.15 (chill)	112	96.0

The hardness remained unaffected by the addition of vanadium.

It is specially recommended for motor car cylinders, and plates for moulds or dies of stamping; it takes a perfect surface and high polish with good resistance to wear. Kent Smith also states that with chill castings the addition of 0.20 per cent. increases the depth of chill by about 10 per cent., and gives three times the life of ordinary metal as regards wear.

G. L. Norris * agrees in the main with Kent Smith's conclusions, and states that vanadium exerts a strong refining effect on the grain of the iron, eliminates porosity, and promotes soundness, increased strength, resistance to wear, and rigidity. He strongly advocates the use of vanadium iron for loco. cylinders, giving as examples some cylinders on the New York Central Railway which, after running 200,000 miles, showed only microscopic wear, while the iron to which no addition was made wore 1-32in. after running half the distance. He quotes tests to show that about 0.12 per cent. vanadium added to the metal increased the transverse strength by 9 per cent., and the tensile strength by about 18 per cent.

E. O. Fitch, junr., ** also deals with the characteristics of vanadium iron. It is stated † that cheap mixtures may be employed by using iron containing vanadium, and a series of tests are given.

The most exhaustive discussion of the influence of vanadium on cast-iron so far published is by W. H. Hatfield, ‡ who deals with the manner in which the element exists in the alloy. The bulk crystallises with the cementite, and increases the stability of the carbide to heat treatment. Hatfield states that the deductions to be made from the results of his experiments are :—

(1) Additions of vanadium have a definite influence upon the physical properties of cast-iron.
(2) This influence is mainly that of assisting the carbon to persist in the combined state.
(3) The persisting carbides physically do not differ from the normal carbide found in cast-iron.
(4) Owing to the actual presence of much of the vanadium in the carbide, the carbide is rendered more stable.

* Journal Russian Metallurgical Society, 1915, and Iron Age, 1916, vol. 98, pp. 396-397.
† American Foundry Association Journal, 1907.
§ American Foundry, 1909; FOUNDRY TRADE JOURNAL, vol. xiv., p. 144.

* New England Foundry Association, 1910, FOUNDRY TRADE JOURNAL, Vol. 12, p. 647.
** Iron Trade Review, 1915, Vol. lv., p. 72-74, Vol. lvii., pp. 221-222.
† Foundry, 1915, Vol. xliii., pp. 279-280.
‡ Journal Iron and Steel Institute, 1911, I.

The author has obtained the following results on grey iron:—

Vanadium added	Load. Lbs.	Modulus of rupture. Lbs./sq. in.	Hardness.
0.	509	44,310	228
0.15	577	55,180	217
0.25	594	56,070	217

It may be interesting to record that several of the special elements referred to have effects upon both liquid and solid contraction of the material. Boron, molybdenum, tungsten, and chromium very largely increase the shrinkage, especially the boron and tungsten. The former also exhibited a colour display in the gate during cooling and solidification. Nickel causes a slight increase in the draw, as also does vanadium, although in neither case is it sufficient to interfere with casting.

The microscopic and physical features of some of the alloys are exceedingly interesting, and the author regrets that time does not permit of him dealing with them on the present occasion, but he hopes that this preliminary survey may be sufficient to indicate the possibilities of alloying some special elements with cast-iron. Many of the alloys show somewhat remarkable behaviour under heat treatment and repeated heating and cooling.

It is hoped shortly to publish in full the results of investigations which have been carried out recently and are still in progress at the Royal Technical College, Glasgow.

The author acknowledges his indebtedness to Mr. M. Riddell, of Watson, Gow, & Company, for foundry facilities and much valuable assistance in carrying out the experiments; also to Mr. Geo. Pate, of Carron Iron Company, for a supply of specially selected pig-iron.

Correspondence.

Trade and Commerce.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—My Council desires to place the following statements before the public at large, in the hope that the vital importance of the subject they deal with will be realised before it is too late, and the nation finds itself committed to a policy little short of suicidal in its ultimate effects.

The exigencies of the war have led the Government to adopt control of practically the whole trade of the country, but, unfortunately, in doing so, they have almost entirely neglected to make use of the services and experience of the merchant trading community of the nation. As a consequence of this neglect, the interests of the public at large have suffered to an incalculable extent, while the merchant trading community as a class is now facing a position little short of disastrous. The Government has not only taken over the control of trade, but has also taken to trading on its own account, ostensibly to regulate supplies and prevent profiteering, but, unfortunately—and owing, no doubt, to the inexperience of its officials—with results quite the opposite.

At the same time Government officials have been very indiscreet in dealing with the detailed information which traders have been compelled to communicate to them, and this information has reached their competitors at home and abroad, and the result has been the practical confiscation of their entire business.

Our export trade with continental countries, such as France, Italy, and Portugal, has been almost entirely taken out of the hands of the merchant traders by whom it was worked up and developed, and handed over to British Government Departments and to organisations formed in those countries under official Government sanction (but trading for profit), which have had access to the fullest details of our business, and to whom our Government has in some cases insisted on handing over contracts already definitely entered into between British exporters and their foreign clients (including all profits accruing). Certain Government Departments are even now insisting that no consumer shall on any account place an order with a merchant house.

The sure and certain result of the present policy, if persisted in, will be neither more nor less than the utter ruin of the established business of a very considerable section of the community, a section noted for its energy and enterprise, and the jeopardising of our whole foreign commerce by the deliberate scrapping of the organisations of proved efficiency and adaptability through which it has hitherto been conducted.

Now the restoration of our national financial position after the war will depend entirely upon the recovery of our export trade and its vast extension. No bureaucratic organisation can ever handle this trade with the efficiency and ability of the merchant traders, whose wide experience of foreign markets and the special handling which they require, both in respect of the class of merchandise to be supplied and the methods of finance, etc., is an asset of incalculable value to the nation.

The iron, steel, tinplate, and metal merchants of this country, recognising the serious state into which the nation's trade is surely drifting, have formed themselves into a Federation, in order, by every means in their power, to endeavour to remedy this state of things. They invite the other classes of the merchant trading community to form similar federations with the same objects, and to join in the united effort to remedy and prevent, as far as possible, the fatal ultimate results which are inevitable unless the methods adopted by our bureaucratic Government Departments are immediately corrected.

My Council considers that these Government Departments, which were set up for war conditions only (and which would not otherwise have been tolerated for a week), desire if possible to perpetuate their existence, and if they are allowed to have their way now they will wreck the whole system upon which our world-wide trade has been built up and established.

My Council fears that our Government officials are obsessed with the idea that the large organisations of manufacturers in Germany and the U.S.A. are examples to be copied in this country, forgetting that these were not imposed by the State, but were the outcome of the uncontrolled efforts of the commercial community, and that these organisations never attempted to interfere with the established channels of trade, but, recognising their very high value, made the fullest possible use of them.

Undoubtedly an immense amount of man power and expenditure could have been saved to the State during the war if, from the outset, the merchant traders of the country had been taken into consultation by the Government equally with the manufacturers and labour, and had been represented on the various committees appointed by the Board of Trade, the Ministry of Munitions, and the Ministry of Reconstruction.

Yours, etc.,

C. T. EVENNETT, Secretary,
The British Federation of Iron, Steel, Tinplate, and Metal Merchants.
August, 1918.

Cast-Iron Shells in Permanent Moulds.

Under the above heading MR. EDGAR A. CUSTER read a Paper before a recent meeting of the American Foundrymen's Association, at Boston, U.S.A. At the outset he pointed out that there was nothing new in the use of cast-iron projectiles; before the age of steel they were the sole means of battering down defences and attacking at long range. Some of the reasons why the use of cast-iron shells was abandoned were that the metal had never had a very good reputation for uniformity and freedom from sponginess and gas holes; its tensile strength was low and it lacked toughness. Any of the defects commonly known in cast iron would seriously

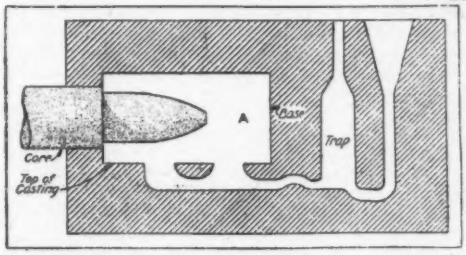


FIG. 1.—TWO-PART CAST-IRON MOULD OR SHELL BUSHING WITH 15-IN. OF METAL SURROUNDING THE GATES, RUNNERS AND CASTING.

affect the trajectory and direction of a shell and render it comparatively useless. The objection to steel projectiles was that they were comparatively ineffective against earthworks or trenches when the calibre was 5 in. or less. The amount of contained explosive was small and a great proportion of the explosive effect was used in bursting the walls of the shell. In larger sizes this objection was less apparent. The present war had taught us that steel, concrete and brickwork offered but little resistance to modern siege guns, and they had been abandoned for earthworks manned with an ample force.

It is essential for the work of constructing cast-iron shells, continued the author, that the degrees of fragmentation of shells be calculated to a nicety. Too great fragmentation will make the shell ineffective. A steel shell weighing 13½ lbs., when charged with 1 lb. of T.N.T., will burst into approximately 1,050 pieces if there is complete detonation. The largest pieces average 0.3 to 0.4 lb. in weight and many of these are splinters due to the fibrous nature of the metal. The fragments recoverable have a wide variation in weight, as shown by the fact that while the average weight of the large fragments is almost half a pound, the average weight of all the fragments is about 0.01 lb. It follows that a very large per cent. of the fragments would do no harm. A cast-iron shell under the same conditions would burst into nearly 1,500 pieces with the fragments comparatively uniform in size and weight.

When it comes to making a projectile of cast iron that is to be used against an enemy, a number of difficulties are met. It must be very strong, easily machined, absolutely solid and free from spongy spots and blowholes, and, above all, every shell must have exactly the same degree of toughness. To meet these requirements, the foundry must be run on a strictly scientific basis. There can be no guess work. When shells are cast in sand, the elements of carbon, silicon and manganese must be held to very definite limits, and these limits vary with the thickness of the shell walls, which can only be determined by trial. The point aimed at is the correct degree of fragmentation and all foundry methods must aim at this. Dry-sand moulds, open and porous; perfect cores and trap or swirling gates must be used. The methods of melting and care of iron and fuel must be carried out whether the shells are made in sand or in a permanent mould.

Ordinary foundry iron, when properly cast in a permanent mould and when removed at the proper time, has, in the resultant casting, the same degree of hardness irrespective of any variation in the chemical constituents, so long as the same size, weight and shape of casting is made. The time the casting remains in the mould is the determining factor of the degree of hardness. A casting

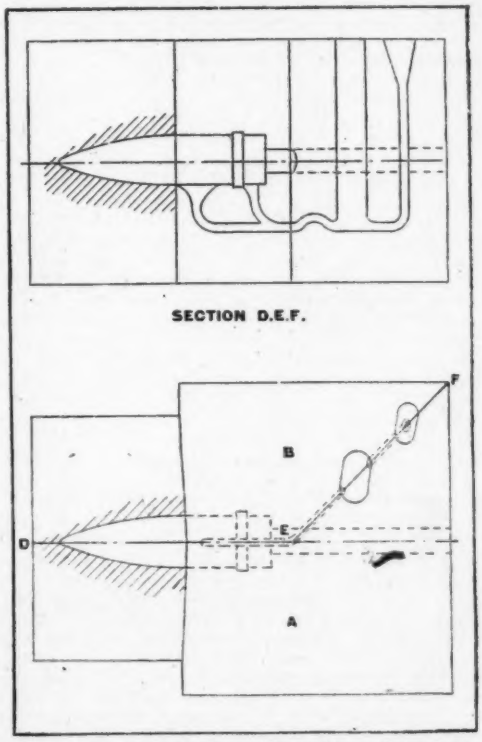


FIG. 2.—SKETCH OF A THREE-PART PERMANENT MOULD FOR A 60-LB. SHELL.

weighing about 60 lbs. remains in the mould four or five seconds, while a casting of the same general contour weighing 500 lbs. will require from 25 to 60 seconds before it is safe to lift it out.

To illustrate this point, data on a casting weighing 1,100 lbs. are presented. Fig. 1 shows the general outline of a mould that was used to

make a shell bushing. A trap gate was used and the casting had a very heavy base and comparatively thin upper walls. In fact, about 65 per cent. of the total weight was concentrated in the lower third of the casting. This large mass of metal increased the time interval in that it was necessary to set the walls deeper than in a casting of smaller bulk. There were no risers, and the only means provided for the escape of air from the matrix were a few shallow channels cut into the mould at the top of the casting. A large cast-iron core operated by a hydraulic cylinder formed the interior cavity. The mould was opened and closed by a similar cylinder. Into this mould irons of the following analyses, all of which were melted in an ordinary cupola, were poured :—

	Mixture No. 1. Per cent.	Mixture No. 2. Per cent.	Mixture No. 3. Per cent.	Mixture No. 4. Per cent.
Manganese ..	1.50	0.50	0.80	1.50
Sulphur ..	0.03	0.05	0.06	0.03
Silicon	1.05	1.75	2.25	1.05
Phosphorus ..	0.05	0.06	0.06	0.05
Steel scrap ..	—	—	—	16.00

From 10 to 12 castings were poured from each of these irons, and when the castings were broken not one showed the least sign of sponginess or gas holes. The mould was poured full, and the first part to freeze was the entrance gate, so that there was no possibility of feeding. Only enough iron was poured to fill the cavity.

The time of setting was measured by the time the core remained in the casting before it was safe to draw it. No. 1 iron required 1 min. and 20 sec. before the core was drawn. When the core was allowed to remain in the casting 1 min. and 30 sec., it was gripped by the iron and had to be cooled to room temperature before removal was possible. No. 2 iron required 1 min., and No. 3, 30 sec. In No. 4 a new condition was set up when 16 per cent. of scrap steel was melted with the charge in the cupola. In this case it was 2 min. and 20 sec. before the core could be withdrawn. The results show that in a casting of this size the low silicon iron cools much slower than one of higher silicon content. The effect of the long time in the mould was to make the casting very hard, and heat treatment was given to bring it to machinability. The temperature of the core had no effect on the time of setting. The tenth casting was given the same time as the first, although the core was heated to a temperature of over 400 deg. Fah.

For a shell that, when finished, weighed 60 lbs., a mould was made in three parts, as shown as shown in Fig. 2, and was equipped with a cast-iron core. The portion of the shell forward of the bourlette band is cast in the solid part of the mould and no provision is made for venting. The parting of the movable portions of the mould runs in a straight line through the centre of the shell and extends 3 in. beyond the base. It then turns at an angle of 45 deg. and runs straight the remaining distance to the outside of the mould. The pouring cup is placed about 5 in. from the outer end of the parting and the main sprue runs down to an easy curve to the bottom of the trap. The entrance to the trap is ¾ in. in diameter, while the main sprue is 1½ in. in diameter. The trap gate is 5 by 4 in. with heavy filleted corners and open at the top The sides are given ¼ in. draught, so that the moving parts of the mould will open readily. The bottom of the trap is set low enough to allow a slight hump to be placed in the runner between the trap and the matrix. This hump serves to catch any air or dirt that may be carried with the first rush of the metal. The centre line of the runner is 3 in. below the bottom of the matrix and two gates are cut—one between the revolving band and the base and the other between the band and the bourlette. The gates are 1-16 in. wide, and have a small fillet where they enter the matrix. The mechanism for drawing the core is attached to the part A and moves with it. Channels are cut in A and B in the proper position to receive the copper band.

The operation of casting is as follows:—The copper band is placed in the channels, the mould closed and then poured as fast as the runner will take the metal, keeping the pouring cup full until the end. In four seconds the core is withdrawn, the mould opened and the casting removed. The copper band will be firmly cast into place.

It was found that a mixture corresponding to No. 4 in the experiment previously mentioned, with the exception that the manganese was under 0.08 per cent., gave the casting the toughness necessary for the proper degree of fragmentation, but the long exposure in the mould made the casting too hard. A scleroscope reading of 65 to 70 was the invariable result irrespective of any difference in the mixtures. It was evident that some form of heat treatment was necessary to bring the casting to a workable condition. It had been determined that a mark of 45 would give the proper degree of fragmentation. A number of trials were made before it was found that a "flash" heat of 865 deg. C. would restore the casting to a good workable condition and bring the scleroscope to just about the correct figure. It was further found that the castings should be allowed to cool before being subjected to the treatment, so that a number of shells could be treated at the same time, starting at the same basis of temperature.

In a permanent mould, it is impossible to get a casting free from gas or air holes without the use of trap gates. There is no trouble in filling the mould when semi-steel is used. The metal does not need to be poured especially fast. Nevertheless, unless a substantial trap gate is provided, small holes will collect against the bottom of the core and the top of the casting. The most careful pouring will not change this condition. There is a point when semi-steel can be poured in a permanent mould without these holes forming and without trap gates, and that point is when the metal has cooled until it is almost viscid. The difficulty of successfully hitting this point is so great as to make this method beyond the range of commercial success.

The selection of different irons for different sizes of shells, made in permanent moulds, is not necessary. To explain this, the influence of silicon and manganese is exerted only when the molten metal is cooling in the mould, and the total effect of this influence is measured by the time the molten metal takes to become solid. In a sand-cast projectile weighing 65 lbs., the time is five minutes; in a permanent mould casting the time is five seconds.

When cast-iron shells are used in the open, the fragmentation must be exact, but when used against earthworks, only the explosive force counts. Since it is impossible to set aside shells for each duty, it is obvious that the degree of fragmentation must govern the process. This is easier to

accomplish with a permanent mould than by any other known process. As has been said, the question of hardness does not depend upon the variations of the pig-iron so long as ordinary foundry iron is used. The same statement is true of the so-called semi-steel so long as the same percentage of steel scrap is melted with the iron. The term "ordinary foundry iron" is used to denote pig-iron ranging from 1.75 to 2.75 per cent. silicon, below 0.80 per cent. manganese and with sulphur below 0.08 per cent. Phosphorus has no appreciable effect up to 1 per cent. A casting that would analyse 3 per cent. total carbon, 1 to 1.20 per cent. silicon, 0.60 per cent. manganese, 0.05 per cent. sulphur (using 16 per cent. steel scrap) would be an ideal composition for a 60-lb. shell. All shells, whether cast iron or steel, must be subjected to a definite heat treatment, and, in the case of cast iron, the degree of heat and time of exposure to get the proper scleroscope test can be determined only by experiment.

As to the design of the mould, the main point to be considered is that plenty of metal should surround not only the matrix but also the sprues and runners. In a casting, such as a 5-in. shell, there should be at least 10 in. of metal outside of every portion of the mould that comes in contact with the molten metal. The purpose of this is twofold: to provide a sufficient heat storage capacity so that the molten metal will be robbed of its heat in the shortest possible time and to make the mould strong enough to resist the tremendous expansive power of the cooling metal. The matrix and the core should be made to the exact size of the casting before finishing.

Make no allowance for shrinkage. Why there is no apparent shrinkage when these castings are made in a permanent mould is a moot subject. It may be that since the interior of the casting is molten when it is taken from the mould and the outside contraction has not started at the time of removal, the expensive force of the cooling interior metal will neutralise the contracting force of the cooling exterior. It is a very interesting point, but it is true that when the casting is so thick that the interior is molten at the time of removal, shrinkage may be safely ignored.

The mould should also be so equipped as to be easily and quickly opened and closed. The movable portions should run on grooved wheels fitting V-shaped tracks. The purpose of this is to prevent small particles of iron interfering with the adjustment of the moving parts. Casting is apt to be a sloppy proceeding, and there are always small particles of iron splashing around. Mount the moulds so that there is plenty of space underneath to collect any molten metal that may carelessly escape. Before closing the mould, run a flat scraper over the face to remove any small particles that may adhere. If these general rules are followed out, two 60-lb. shells can be cast every minute, and all will be of the same weight, size and texture.

The position of the copper revolving band is an important consideration. In some steel shells this band is placed within a very short distance of the base, but in a cast-iron shell plenty of metal must back up the band. Even with the strength that steel gives, portions of the base are sometimes torn off by the tremendous force set up when the band enters the rifling at a very high velocity. The effect of this rupture is to disturb the trajectory and direction to such an extent as to render the shell not only useless but dangerous.

French Specifications for Iron Shells.

The French Government has issued specifications for shells cast in sand that are here given in part. They call for the analysis of shells of 122 to 155 mm. calibre. The chemical analysis is as follows:—

	Per cent.
Graphitic carbon	0.70
Combined carbon	2.40
Silicon	1.35
Manganese	0.70

The amount of total carbon and silicon must not exceed 4.7 per cent. If this limit is exceeded, the iron will lack toughness. At least 2 per cent. of the total carbon must be combined to produce proper fragmentation. The percentage of dust increases as the combined carbon decreases. Although the sum of total carbon plus silicon is set at 4.7 per cent., it is preferable to keep these limits to 4.4 per cent. with a minimum percentage of silicon. The percentage of silicon varies according to the type of moulding. In the 122-calibre the best results were obtained by using a minimum of 1.20 per cent. silicon for dry sand and 1.35 per cent. for green sand. The percentage of silicon varies in inverse ratio to the thickness of the walls and the calibre; the thicker the wall, and higher the calibre, the lower the silicon. Manganese decreases with the thickness of the walls and calibre and increases with the sulphur.

The sulphur should never exceed 0.08 per cent., and should be lower whenever possible. The percentage of phosphorus is set at 0.15 per cent. or under. The charge should be as follows:—

	Per cent.
Pig-iron	40
Scrap	40
Steel	20

The term scrap is used to denote scrap melted, pigged and charged according to analysis.

These specifications correspond closely to the iron previously mentioned as being ideal for use in permanent moulds. The striking point is that the silicon decreases when a dry-sand mould is used, and this point is emphasised by the use of a still lower silicon in a permanent mould. The percentage of combined carbon will always be high when a permanent mould is used. Once the proper mixture has been determined, that mixture is used irrespective of the thickness of walls or calibre of shell.

In a Paper presented at the recent annual meeting of the American Iron and Steel Institute, Mr. J. S. Unger, manager of the Central Research Bureau of the Carnegie Steel Co. of Pittsburgh, gave an account of the results of experiments carried out by him with a view of determining the effect of phosphorus on the physical properties of soft steel bars. The results, according to him, show that in soft steels an increase in phosphorus of 0.01 per cent. is equivalent to an increase in tensile strength of about 850 lbs. per sq. in., which is practically the same as would be obtained by increasing the carbon 0.01 per cent. Hence, high-phosphorus but low-carbon steels can be used for various purposes, provided the carbon content is decreased sufficiently to compensate for the increased hardness due to phosphorus. None of the steels showed brittleness under cold working, due to the phosphorus. An examination of the results of the various mechanical tests, cold bending of the rivets under a hammer, the severe upsetting in making rivets or large-headed nails, or the fabrication of barrels, automobile parts and separator bowls indicate nothing more than an increased hardness due to increase in phosphorus. This condition remained the same regardless of whether the force was applied slowly or statically, or by shock or blow.

The Foundryman and His Costs.

By F. Andrew.

In many foundries it is almost impossible for the foundry foreman to obtain certain information which is necessary to him if he is interested in the cost of production. In an engineering works where the castings are machined and fitted up, there are certain advantages from the combination, but there are a considerable number of disadvantages, though the reverse ought to be the case. The combination is certainly a great advantage to the foundry on account of the opportunity of providing special tackle for standard jobs, by which the cost of castings may be considerably reduced, and also on account of the facilities for following a job through the machine shop, enabling the foreman to rectify defects which only show themselves in the machining, and especially on new jobs, before any quantity has been made. The moulder who is worthy of the name is also eager for the chance to follow his work through the machinery, and will strive to give satisfaction and become more careful with the things that matter, as a result of his observations. The advantages to a firm in possessing its own foundry are many, among them being the ability to obtain quick delivery, control of quality, facilities for makng alterations, better control of costs, etc.

Many firms who require regularly a large quantity of castings possess no foundry, some possibly for good reasons, but a large number probably for the short-sighted reason expressed by one, who said he preferred to buy good castings, with the emphasis on the good. Apparently, then, the firms who produce nothing but castings do not make bad castings, or, at any rate, do not charge their customers for them. The same labour is available and the same materials also, so there seems to be only one inference to be drawn, that the engineer without a foundry is imposing on the poor misguided creature who is foolish enough to run a foundry for his benefit. Some such foundries do exist, but their life is necessarily short, though sufficiently long to supply engineers with ridiculously low quotations, which some engineers are anxious to regard as a reasonable standard. Foundries that are run on proper lines meet with this type of customer frequently, and if wise put their jobs on one side, till somebody else comes for them. These are the jobs which are constantly being shifted from one foundry to another, and it is difficult to see what advantage the owner of the patterns will get in the long run. In most cases, attention to the quality of the patterns, and orders in sufficiently large quantities might result in the founder making special tackle and supplying castings at a price which otherwise would be ridiculous. Both the engineer and founder would stand to benefit, as the founder would have regular orders, and could give regular supplies, while the patterns would have a much longer life, also the quality of the castings would be more uniform.

The writer's experience with some of these travelling patterns is, that while new they look excellent, but after the first time using, either come out of the mould in segments or require plenty of touching up before being used again. These are the patterns made at a contract price, which means only so much work will be expended on them, using nails instead of screws, no taper, plenty of putty and a final coat of varnish, so that the moulder thinks they have been washed over with glue when he tears them out of the sand, and wonders which end he is going to start finishing.

The foreman of the foundry attached to the machine shop, has very often to put up with a reference to the lower cost for castings which outside firms will supply. This is invariably a reflection on the running of the foundry, though the causes are often excessive establishment charges through unfair distribution, lack of opportunity for improving plant, limited control of foundry supplies, and bad quotations from outside firms previously referred to.

The remedy adopted by the firm is often a change in the foremanship, with no better results if the causes above referred to still remain. To avoid being placed in this false position, it is the duty of the foreman to get to know for himself the cost of production. It is also due to him from his employers to know what proportion of the establishment charges he has to carry, and for him to determine whether this proportion is a reasonable one. It is obviously unfair that he should share the expenses of a modern, well-equipped and well-lighted machine shop, if he has to work in an old building, dark and ill-equipped for the class of work to be produced. The burden he should carry, if his results are to be compared with outside firms, should be limited to the charges on the buildings and plant he makes use of, the power he uses, and a fair share of the management and general office expenses. With such figures he can make a start in estimating the possibilities of his foundry. Certain items in the overhead burden will remain fixtures, and others will vary from time to time. Keeping this in mind, the different elements to be taken into account are as follows:— (1) Establishment charges; (2) productive labour; (3) raw materials; (4) stores account; (5) expenses of distribution and selling costs; (6) profit.

In the case of a shop doing heavy, medium, and light work, much will depend on the organisation and separate control of each section in the determination of the expenses they shall carry.

Establishment Charges:—(*a*) Administrative wages; rent; rates; taxes; interest; depreciation; insurance. (*b*) Power; light; heat; repairs; renewals; additions and extensions; contingencies. Under (*a*) will be found the fixed annual charges; under (*b*) will be found the variable, some of which will eventually be transferred to (*a*).

(2) *Productive Labour*:—Foremen; moulders; coremakers; dressers; crane-drivers; furnacemen; general labour; mechanics. These will be charged to the class of work to which they apply, and in the case of heavy and medium work to each particular order number or job number, the latter being preferable. In the case of light work, which may again be classified, these items to be charged to the weight of good castings produced.

(3) *Raw Materials*:—Pig-iron; scrap iron; ganister, etc.; cupola coke; sand; coal-dust; gas-coke; coal. These will be charged to the weight of good castings produced, with due consideration for castings requiring special iron.

(4) *Stores Account*:—Blackings; binders; chap-

lets; sprigs; oil; shovels; riddles; bellows; mallets; core-rods and wire, etc. These will be charged to the weight of good castings produced, special stores to the job requiring them.

(5) *Expenses of Distribution and Selling Costs* :— Delivery of castings; travellers' expenses; advertising. Other items may occur in this section according to the nature of the business, and the whole will be charged to the output.

(6) *Profit.*—The amount of this cannot be rigidly fixed, as the question of competition and the different market prices will naturally affect selling price.

Items 2, 3, and 4 may be termed direct charges, consisting of (2) labour (direct, plus percentage for supervision and indirect labour); (3) materials (metal, plus percentage for other materials); (4) stores (direct, plus percentage for other stores).

Items 1 and 5 will be added as a percentage according to the average output taken weekly or over any other period. This percentage is usually sufficient to allow a reasonable margin to cover contingencies and unforeseen fluctuations. It is obvious that with a reduced output the percentage for items 1 and 5 must be increased, and therefore for each foundry there is an output below which level it is dangerous to go. On the other hand, considerable rises above this level require attention, as prolonged working hours often result in inefficiency, and if this is the reason for increased output, the result will be that the labour costs will be considerably higher in proportion to those for a normal output. If the increased output becomes necessary it would be more economical to employ two shifts of men, so that while the output might be doubled according to conditions and the class of work the establishment charges under (*a*) would not be materially altered, and which, being heavy charges as a rule, would be reduced in proportion to output, though other charges, such as supervision, power, light, etc., would show a big increase, which, however, would not outweigh the advantages gained on the whole.

In comparing the output periodically, class must be considered jointly with weight; therefore tonnage, unless in regard to the same class, is only a nominal factor, as it is quite possible for a low tonnage to represent the best output.

In foundries where the class of work is fairly regular in character, it becomes, with reasonable organisation, comparatively simple for the foundry foreman to keep the records for the direct charges, as items 2, 3, and 4, under control, and by periodical inspection of the sheets, which may be prepared weekly, fortnightly, or monthly, to determine whether those factors which he controls are favourable or otherwise. Even slight variations will reveal cause for investigation, and result in irregularities being rectified, before much harm is done.

Such methods to many foremen would seem superfluous, but the man who has any such system of control over his costs can command more respect from his employers, scrupulous or unscrupulous, while the man who avoids this section of his business is at the mercy of both. Many will be quick to say that a foreman has enough to do, without going into costs, but it is all a question of the organisation as to whether much of his time is taken up or not. In the case of a large foundry, the foreman will have underforemen who take the responsibility for details, leaving him as head of the foundry more time to devote to the important matters, "costs" being undoubtedly one of them, while the details for these costs are prepared by the clerical staff, consisting of one, two, or more men. With only a small foundry the task is much simpler, and should, on account of the lower labour, material and stores requirements, be well within the scope of the foundry foreman.

The sooner foundrymen recognise their own responsibility in this direction, the sooner will their status improve, and enable them to rank on the same level as the engineer.

Iron and Steel Institute.

Programme of Autumn Meeting.

Mr. G. C. Lloyd (Secretary) has issued the following programme of proceedings at the forthcoming autumn meeting of the Iron and Steel Institute, which will be held at the Institution of Civil Engineers, Great George Street, Westminster, on Thursday and Friday, September 12 and 13 :—

Thursday, September 12.

General meeting of members at 10.30 a.m., when scrutineers will be appointed for the examination of voting papers for election of new members, and a selection of Papers (Nos. 4, 13, 15, 11) will be discussed.

Afternoon session at 2.45, when Papers Nos. 3, 10, 17 will be discussed.

Friday, September 13.

At 10 a.m. the general meeting will be resumed and Papers Nos. 8, 1, 12, and 5 will be discussed.

At 2.45 afternoon session, when Papers Nos. 7, 14, 16 will be discussed.

Papers.

The following is the list of Papers that are expected to be submitted :—

(1) "Principles of Open-Hearth Furnace Design," by C. H. F. Bagley; (2) "The Rate of Change at 100 deg. C. and at Ordinary Temperatures in the Electrical Resistance of Hardened Steel," by E. D. Campbell; (3) "Some Experiments on the Reaction between Pure Carbon Monoxide and Pure Electrolytic Iron below the A1 Inversion," by H. C. H. Carpenter and C. Coldron Smith; (4) "Influences of Hot Working on the Qualities of Steel," by G. Charpy; (5) "The Casting of Steel in Ingot and other Moulds," by J. E. Fletcher; (6) "Notes on a Telescopic Focussing Apparatus for Photomicrography," by A. F. Hallimond; (7) "Case-Hardening Practice," by D. Hanson and J. E. Hurst; (8) "Use of Bosh Tuyeres in the Blowing of Basic Pig-Iron," by J. S. Hollings; (9) "On Magnetic Analysis as a means of Studying the Structure of Iron Alloys," by K. Honda; (10) "Prevention of Growth in Grey Cast Iron," by J. E. Hurst; (11) "Standardisation of Tests for Refractory Materials," by Cosmo Johns; (12) "The Utilisation of Waste Heat from Open-Hearth Furnaces for the Generation of Steam," by T. B. Mackenzie; (13) "Influence of Elements on Tenacity of Basic Steel," by A. McWilliam; (14) "Chemical Standards and their Bearing on the Unification of Analysis," by C. H. Ridsdale and N. D. Ridsdale; (15) "Hardness Testing: Relation between Ball Hardness and Scleroscope Hardness," by A. F. Shore; (16) "Phosphorus in Malleable Cast Iron," by J. H. Teng; (17) "Notes on the Warping of Steel through Repeated Quenching," by J. H. Whiteley.

Essential Properties of Refractories Used in Steel Production.*

By Alleyne Reynolds.

Up to some twenty years ago the author was employed by Messrs. Vickers as manager of their acid open-hearth, crucible steel melting and kindred plants, and also of their gun and armour-plate heat-treatment plants. He had had to produce steels, with most regular success, fulfilling very narrow and severe specifications, and of great variety in regard to composition, and also in regard to weight of the individual ingots and castings. One step in the problem of producing perfect steel being to evolve improved open-hearth furnaces within the limits of present-day refractories' properties, the author considered this, and, as a result, read in May, 1913, a paper entitled "Faults in Present Day Furnaces, and their Remedies," at the meeting of the Iron and Steel Institute. Another step was to endeavour to inspire manufacturers of refractories to produce better and more suitable materials for furnace construction and endeavour to make them understand what properties were required. In July, 1917 the author was pleasantly surprised by the receipt of a letter from Dr. Mellor, in which that gentleman informed him that he had been interested by reading his Paper on furnaces read in 1913 and inviting him to read a corollary Paper before the Ceramic Society. With this preamble the author proceeded to set out his proposed laws of physical chemistry.

The first step in the manufacture of steel, the author continued, must be in the regenerative blast furnace, or its equivalent the non-regenerative electric semi-arc vertical shaft furnace, in which the charge column above the reaction zone forms the most perfect regenerator that can be designed. The sole difference between the blast and the electric furnace is that owing to avoiding transmutation of energy we work more cheaply and more regeneratively with less radiation losses by employing the total fuel in the large blast furnace. The gases are alike in composition save and except for the useful mass action of the nitrogen of the air blast.

The next process should be to treat the shaft furnace product by the acid open-hearth continuous process, using as much limestone as possible to remove the silicide of iron, but using no ore. Above the metal level, and just below the top of maximum slag level, neutral or inert furnace brickwork is needed, at the teeming side, as acid bricks would be fluxed by oxidation of iron into basic FeO. If large lumps of lime carbonate were used, and kept well in the centre of the bath, considerable amounts of iron carbide would be removed, without risk of fluxing the hearth.

The third process should be exothermic refinement to produce lime phosphate. Plenty of carbonate of lime, or lime and iron ore should be used, and the process should be the Talbot process, but producing more commercially valuable slags owing to the acid process preceding it having been on logical lines.

The manufacture of pure iron is impossible, and the manufacture of steel originated out of attempts to produce iron. It was then found that steels, or alloys of excess reagents (deoxidisers) possessed better physical properties than iron was likely to possess, could it be made by a caloric process. Where skill comes in is in the last process of refining out the last traces of the refining agent. This is FeO. It would be out of place to omit reference to the pneumatic steel processes, and to omit to give credit for the discovery of their nature to Dr. J. E. Stead. The proper sequence of separate stages of steel refinement must be the sequence of reactions in the Bessemer converter. The order of oxidation is at low temperature, silico-manganese, silico-iron, carbon, phosphorus. At high temperatures silico-iron is not only not attacked but formed. Then the sequence is silico-manganese, carbon, phosphorus. In the basic process where phosphatic slags may be in existence as calorytes, in addition to silicate calorytes, the carbon reaction merely requires high temperature, and is independent of the phosphorus reaction. Of course mass action affects the case, but with progress of refinement the metal becomes a more steading caloryte. Clearly then the fourth process which the author insists on must be a treatment by silico-manganese.

For years past the author has been trying to get metallurgists to realise that whenever steel is produced low in oxygen content it is always, and always has been, due to added or nascent silico-manganese, and nothing else. The best steel-makers add silico-manganese instead of awaiting its formation from silicide of iron and carbide of manganese. The reason acid steels are better than, instead of inferior to, basic is because steel-makers cannot avoid its formation. The acid vessels provide for its formation at a greater rate than the formation of ferro-silicon and iron protoxide, and thus they provide passable steels. Some ten years ago the author mentioned his ideas to the late Mr. S. B. Halcomb, the then technical managing-director of the old Sheffield crucible steel-making firm of Sanderson Bros. & Newbould, Ltd. (established in 1764), and that gentleman recognised at once that they accounted for hundreds of observed facts, especially those relating to dead-melting, in a manner that no other theories had done, and it led to that gentleman and the author making arrangements to co-operate in making trials with a view solely to providing proof, or disproof, of the basic theories in question, without regard to whether the steels produced were usable, or even likely to be so. The main object was to provide preliminary evidence to justify expenditure on more costly trials, having in view producing evidence regarding the author's patented remedial process. As a result the author is enabled to furnish (as appendices, not reproduced here) what he believes to be trial results of a quite unique value as demonstrating the course of chemical reaction in steel manufacture. These trials are of additional value as being conducted in an actual manufactory under conditions pertaining to actual manufacture.

When steel is separated from the slag and contains any oxygen, as temperature is degraded slags are formed, and these cannot be in equili-

* Abstract of a Paper read before the Ceramic Society.

brium with the metal at the isothermal lines of freezing in the mould. In the result segregation of slags, gases, and elements, or more correctly acidates, anhydrides, and acidides takes place. Further acidates are held in solution in the superior phase portion. Usually the segregation has the effect of carrying the acidides into the eutectic, save of course the silicide of manganese which must be associated with the silicate of manganese. Sulphides of metals of the iron group being basides rather than acidides, are affected by the influence of the basic oxides.

The segregation in steel ingots increases with their size, and is really due to the action of traces of FeO which have not been removed, owing to omitting the making of the finishing process separate from, and in a separate apparatus to that employed for the refining process, and absolutely invariably exposing the steel after leaving the furnace, to the action of a ladle lining, casting nozzles, and direct Bessemerising influences which would undo the perfection of perfect steel subjected to such obviously bad treatment. The segregation is great in ingots of moderate weight. The steel-maker is put under the severest call on his skill as a metallurgist in the manufacture of heavy ingots for forging into the costly inner tubes for large guns, such ingots exceeding 100 tons weight.

It is a simple and easy matter to shield the steel absolutely from Bessemerising influences, but nothing can render the production of perfect steel possible, and its perfection being reattained possible, save and except its never coming into contact with any acidate which is not neutral or basic, from the commencement of its finishing process and thereafter. That is the problem which ceramists and steel-makers must at once realise is so important that it is almost a national sin to allow any expenditure of time and capital to stand in the way of it. Quite apart from other serious action of acid ladle, and tundish linings on the steel, there exists a defect that renders them incurably harmful. They become neutralised on the surface mainly by the formation of monosilicate of manganese. On emptying the ladle this thick glaze becomes very rapidly roasted, the protoxides of Mn and FeO being oxidised and becoming particularly effective oxide ores. On next filling the ladle these alone are enough to blight a perfect steel. Their reduction increases the amount of glaze, and when this has increased to a certain degree it floats off in bulk, leaving active silicate exposed to the steel. Yet some steel-makers are surprised at cyclic epidemics ocurring in their manufacture. Ceramists should note the danger of traces of alkalies in the materials used in the final stages of steel manufacture. They may facilitate all sorts of dangerous, obscure, and subtle actions, perhaps nitrogenation of steel, the next greatest danger to oxygen.

Inasmuch as iron ores are mainly oxides, secondly carbonates, and thirdly sulphides, it stands to reason that it must be most difficult to make iron dead free from (1) oxygen, (2) carbon, (3) sulphur, and the author fears no contradiction from any practical steel-maker who has essayed the problem.

In connection with the amalgamation with Ruston, Proctor & Company, the business of Richard Hornsby & Sons, Limited, is being wound up voluntarily. Mr. W. Haynes, Grantham, secretary of the company, and Mr. R. Smith, Lincoln, have been appointed liquidators.

Converter Steel Castings.

Mr. John Sonnenfeld, in a recent issue of "The Iron Age," commenting on a recent article of Mr. R. F. Flinterman, in the same paper on "Electric Steel Castings," states that the present abnormal conditions seem to be responsible for the increased introduction of the electric furnace, but the question is, will it hold its place when the rush is over? Will it be the ideal apparatus?

The concessions recently made in the U.S. Government specifications do not necessarily mean that the converter is not able to meet the old specifications; in fact, the writer's firm, the Lima Steel Casting Company, of Ohio, is making both Army and Navy castings in quantities, and has never had much trouble to meet and exceed former specifications. Some converter plants do not live up to expectations, but this cannot be adopted as a general rule as there is, on the other hand, the great majority which are successful in every respect. This applies also to the electric furnace. All electric furnaces are not working to entire satisfaction. A converter plant is successful when it can make any grade of commercial castings, but this is only possible when the conditions around the converter are right. The cupola iron has to be hot enough, and has to have the right chemical composition, especially as to silicon, which varies with the size of the converter and tuyeres, but in no case should the silicon be above 2.20 per cent. nor below 1.80 per cent. The tuyeres should be in good shape, and tight, and the proper air pressure in the wind box maintained. Admitting this to be correct, there are two distinct stages in blowing a good heat: The first flame and the last flame. The first flame has to come up distinctly after the wind is put on, in two to four minutes, and the last flame has to disappear even as distinctly after all impurities are oxidised. What remains in the vessel is much overheated iron almost free from all ingredients except oxide. This is removed by ferro-silicon and ferro-manganese, the excess of which remains in the steel. Addition of iron from the cupola regulates the carbon to the desired point. Thus, everything might be satisfactory were it not for the sulphur, which at present cannot be removed from converter steel. But why remove it? Why put it in in quantities which will endanger the quality? The sulphur content increases both in the cupola and in the converter, in the latter due to conversion losses. Taking, for instance, the mixture prior to melting, at 0.04 per cent. sulphur, and the conversion losses at 17 per cent., which will increase the sulphur to 0.046 per cent. The finished steel, however, will show a sulphur content of 0.10 per cent., which means an addition of 0.054 per cent., or over 100 per cent. The increase of sulphur comes from the coke in the cupola. The longer the iron stays in contact with the coke the more sulphur it will absorb, and this means that the increase of sulphur is in direct proportion with the time of contact in the cupola. Therefore, the iron has to slide down the cupola in the shortest time possible, and the cupola has to be of such size that in order to melt iron for one heat it should take just as much time as it takes to blow a heat. This means that if the capacity of the cupola is too large for the capacity of the converter, the air in the cupola has to be shut off until the converter is ready to take the metal. Thus the iron has a chance to pick up more sulphur.

It is interesting to notice how some converter foundries get out a large production with a small melting unit, and again how others run low in output with large units. Of two converters of the same design and capacity, one will produce twice the amount that the other will. The reason is a simple one. The operator of the one converter has more ability than the other. The Lima Steel Casting Company, for instance, has a 1-ton converter, a moulding floor space of 11,000 sq. ft., and the production in May was 393 heats and 331 tons of good castings, whose average weight was about 12 lbs. each. The average number of heats for May was 14.6 per working day, and there are many other foundries than can do the same or better.

Templates and Patterns for Pipes

By James Edgar.

In a shipbuilding yard for certain classes of work it is only possible for the drawing office to give approximate sizes to the pattern-shop. It is not possible, for instance, to give the angles of flanges on valve chests which have to be fitted directly to the shell of the ship, and although on new work templates may be made in the moulding loft, this is not possible on repair work. Pipes, however, comprise the largest portion of the work which has to be made or tried to place. When there is a line of valves and pipes they are all made to definite sizes, except one, which is called the closing pipe. It is quite customary for engineers to deviate from the arrangement drawing, and the only safe way to ensure a closing casting fitting correctly is to build a template in the position in which the casting will be, and from this template the sizes are obtained for the pattern. It is generally less troublesome to fit pipes than to fit valves, because the valves have to be levelled carefully, taking into consideration the rake of the ship, whereas for pipes it is only necessary to guard against touching other castings that may be very close. Templates must be rigid or they are unreliable. There is considerable scope in this class of work for the exercise of ingenuity and initiative. The men who are chosen for the work are usually chosen because they have self-confidence. It is not possible for the foreman pattern-maker to visit the ships much, and he cannot check the patterns in the ordinary way before they go to the foundry. Consequently, it is usually the men of long experience who have the monopoly of shipwork, although there is no reason why any pattern-maker who knows what is required should not make good templates.

An unsightly template which is rigid is better than a beautiful piece of workmanship which cannot stand handling. It does not matter how rough a template is. It is advisable to plane the faces of the flanges, but it does not matter for anything else.

FIG. 1.

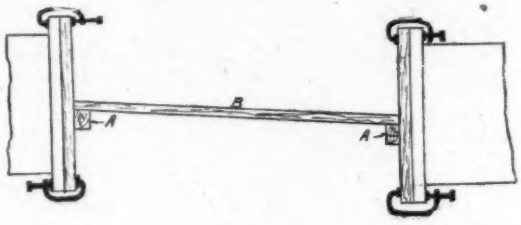


FIG. 3.

Templates consist of faces or flanges, and usually a centre plate with supports. It may be possible, if for a new ship, to make the faces before visiting the ship at all; but it is generally better to first examine the place for which the pipe is wanted. To save delay the pattern-maker is occasionally sent for before the line of pipes is properly erected. They may be temporarily bolted together and slung from beams or girders, the slightest push moving them. The pattern-maker's task is thus made more difficult, and the possibility of a bad fitting casting is increased. It is wise in such cases to double the machining on the faces of the flanges of the pattern, as it is better for the flanges to be thick than for a liner to be put in. When the pattern-maker visits the ship, all he need do is to measure the sizes of the flanges of the connecting pipes and the distance between. It will then be possible for him to make the flanges in the ship and get strips of timber 4 or 5 in. wide, which can be cut to required lengths on the ship. It may be necessary to erect a scaffold, but timber for this purpose is usually to be picked up on the ship, and very frequently a suitable scaffold is put up by the riggers.

Some pattern-makers make a cross, like Fig. 1,

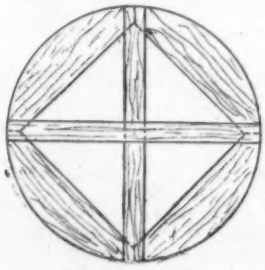


FIG. 2.

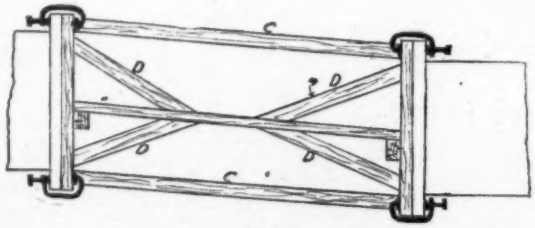


FIG. 4.

instead of flanges, but it has some disadvantages. It is more quickly made than a circular flange, but it is not sufficiently rigid, and as the template will probably be used in the machine shop for machining the flange faces and also for marking the belt holes, it is better to make a flange from 1¼-in. timber. Fig. 2 shows a suitable flange. It is simply a half-lapped cross with diagonal pieces either screwed on the face or checked into it. Of course, if the pipe is small up to, say, 1 ft. in diameter, it is easier to make flanges from piece of timber. Figs. 3 and 4 show a comparatively easy template.

FIG. 5.

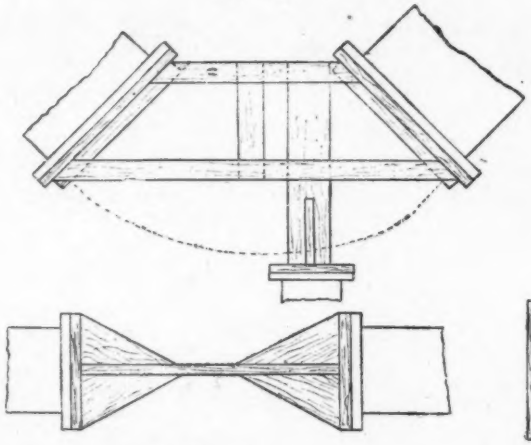
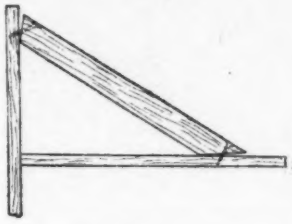


FIG. 6.



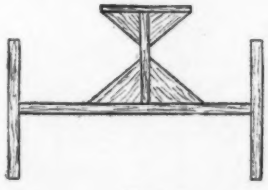


FIG. 7.

FIG. 8.

The flanges are first clamped in place. Two clamps are sufficient if the flange is small, but if they are large flanges of 36 in. or more in diameter, more will be necessary to support them. The writer has shown in Fig. 3 the flanges and centre frame fitted, and all the stays left off that the reader may not be confused. The blocks A A are screwed on the flanges, and if a bevel is used in setting them, it will ensure them being on the same plane. There must be no rocking motion when the battens B are laid on the blocks, otherwise when the clamps are removed from the flanges the template will spring and be incorrect. Sometimes a half-lapped frame is made for the centre B, but it is not necessary. When narrow battens are screwed on to the pieces A a strong frame is made.

The next operation is to fit the pieces C C, Fig. 4. They may be either screwed to blocks on the flanges, or pocket-screwed directly on to the flanges. If stays D are now fitted carefully, a rigid template will result which will not yield when it is being hoisted from the engine-room to the deck. Fig. 6 shows one of these stays badly fitted. It will be readily seen that the screws will pull the centre plate or the flange, and when the cramps are removed the flanges will drop back. When the template is completed it ought to be possible to remove all the grips without any danger of the template falling. With smaller pipes, say, to flanges that are 12 in. in diameter, or even more, a simpler template like that shown in Fig. 7 is quite good. After the centre plate is screwed in place, centre baskets can be fitted on either side of it. For still smaller pipes when the flanges are only a few inches in diameter, blocks can be screwed to the flanges before the pattern-maker leaves the shop, and all it is necessary to do on the ship is to plane these blocks to the proper bevel, as, of course, one flange may be on a different level to the other, and screw on a plate which need not fit hard against the flanges. The arrangement is shown in Figs. 9 and 10.

It is sometimes necessary for a branch to be on a closing pipe, and as seen in Fig. 8, it can easily be supported on the centre plate. This centre branch may be on a different plane to the pipe proper, but unless there are other castings close, the shape can usually be decided when making the pattern in the shop. Fig. 5, however, shows a pipe where it might be advisable to have an approximate shape before leaving the ship, so that either the engine-room foreman, or the draftsman, would know exactly the design of the casting. The template itself is made in the ordinary way, but either a piece of thin wood—say, ¼ in.—or a sheet of cardboard should be laid on the centre frame, and the proposed shape drawn on it, especially if there is a possibility of the pipe touching the bulkhead

FIG. 9.

FIG. 10.

or other pipe, this is a good guide when making the pattern. The space in the modern engine-room is very congested, and this is one reason why it is always advisable to consult the engine-room foreman as to the shapes of pipes.

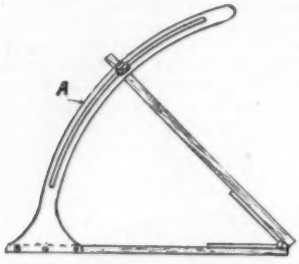


FIG. 11.

One of the most awkward pipes to fit is a pipe between two flanges that are almost in line with each other. An S bend has to be made, and the design must be such that the flow of water or the passage of steam must not be hindered. There are

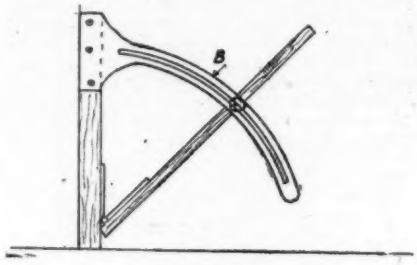


FIG. 12.

It is sometimes very difficult to get the template out of the engine-room, but under no consideration should it be dissembled, as it is practically impossible to erect it again so that it can be relied upon.

We shall now consider making patterns from

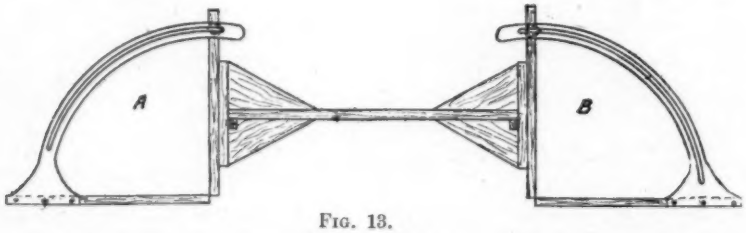


FIG. 13.

times when a closing pipe is unavoidably very long, and it may be advisable, both for convenience in making the template and pattern, and also for handling the casting, and getting it into place, to make two castings instead of one. When this is

templates. In all pattern-shops where large work is made there ought to be a level building floor. The best floor is in the form of a platform raised about 2 ft. above the ordinary floor. If the building floor is on the ordinary floor level, it is so

FIG. 15.

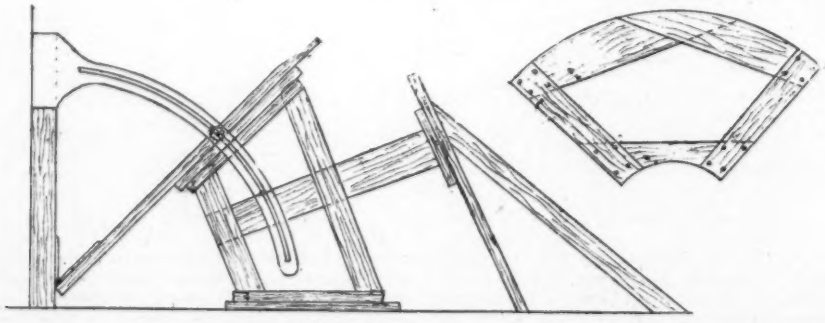


FIG. 14.

done, it is wise to make two templates, joining them at a convenient place. It is not always possible in such cases to wait until one casting is in place before the second template is fitted. The last care of the pattern-maker before bringing away a template is to mark the tops of the flanges so

much tramped on that it soon gets uneven. Drawing boards are very often used as faces for building the pattern between, but brackets like Fig. 11 are much superior. The bracket consists of a base and a hinged plate, which can be adjusted by means of the arms A to any angle. A very convenient size

for the plates is 2 ft. 6 in. square, but, of course, they may be larger or smaller. When allowance strips for contraction and machining have been nailed on the template flanges, the one bracket can be weighted or screwed to the floor, and the plate screwed to the face at a convenient angle. The other end of the template can be propped up until the second bracket is brought against it. (Fig. 13.) A line is drawn round the flange now, and when the template is removed the centre of the pipe can be easily found. It will be necessary to turn the template until the flanges are both as nearly vertical as they can be got, because it is easier to set the pattern flanges horizontally, and if the flanges do not need to be loosened in order that they will deliver from the sand it is better. The bottom half of the flanges should be set first, and the joint plate fitted between them, and resting on strips screwed to the flanges. The top half flanges can be now set and the top joint plate fitted. It is usual and certainly more convenient to make a pattern from a template by the skeleton method. When the grounds made of 1-in. or 1¼-in. timber have all been nailed on the joint plate, the top strip, about 2 in. wide and ½ in. thick, should be checked into them and butted against the flanges.

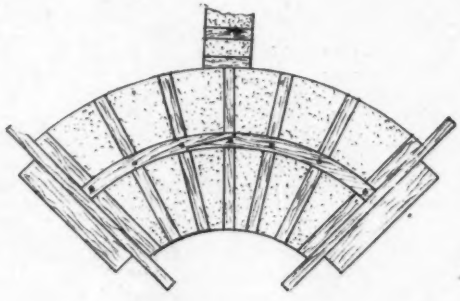


FIG. 18.

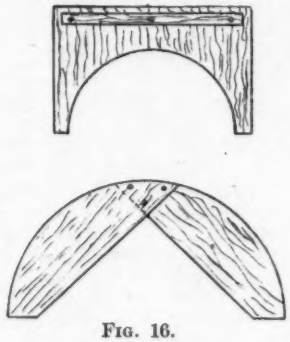


FIG. 16.

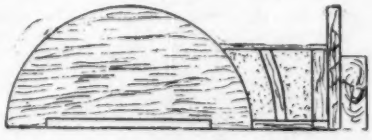


FIG. 19.

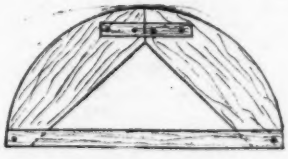


FIG. 17.

A ground, of course, must be screwed behind each flange.

An alternative method to the top strip is to fit a bracket behind the flanges. When the top half of the pattern is finished the whole job may be taken from between the brackets, and if a batten is screwed on the frame of the flanges to ensure their being kept straight, the other half, which was the bottom half when between the brackets, can be easily built. This is a much easier way than finishing the bottom half in place and then building on top of it. The pattern is now completed except for the prints. Two or three inches is the usual distance left between the grounds of skeleton patterns of this kind, although no hard and fast rule is possible, as when making large bends the grounds will have to be wedged at the inner radius and wide at the outer. Very small pipes should, of course, be made solid, and they can, as a rule, be made on a flat board on trestles.

The wall bracket shown in Fig. 12 is useful when making large bends. The two arms B are fastened to strong posts which are against a wall, and the face is lowered to the flange of the pipe. A bend template with a branch is shown in position in Fig. 14. It will be seen that the position of the branch is determined for the pattern by means of a flat board, which is supported by raking stays. Large bends like this may be made with a horizontal joint, but the writer has found it much easier to make the joint vertical, a great advantage being the ease with which the grounds can be screwed from the face of the joint frame. Fig. 15 shows a suitable centre frame for such a pattern, and Figs. 16 and 17 two styles of grounds, the one perhaps equally as good as the other. In Fig. 16 the two pieces are half lapped, but in Fig. 17 battens are screwed across. The latter is the quicker way. In Figs. 18 and 19 is seen the finished bend pattern, and Fig. 20 shows the strickle which ought to be supplied to the moulder for sweeping off the sand which he fills in between the grounds to complete the pattern. The print is removed in Fig. 19 to show the method of making the centre plate to the face of the flange, which is frequently done. The advantage claimed for this is that, especially with a large pipe, the flange is kept rigid. When one of the flanges is not square, and it will consequently be necessary for the moulder to draw it after the body has been drawn, temporary screws should be inserted near the edge. When the pipe is taken from between the brackets these screws can be taken out and the flange screwed from the face.

FIG. 20.

C

There are, of course, several ways of making the cores for such pipes. A corebox is practically never made. They are usually one-off jobs, and a corebox would be too expensive. Sometimes the method of thicknessing is adopted, but thicknessing, apart from being rather expensive in the foundry, has the disadvantage that it is a slow process, and usually closing pipes are wanted in a hurry, because closing pipes are generally the last jobs on ships, and the engineer after the template is made is impatiently waiting until he gets the casting.

It will be sufficient to indicate two or three methods by which the core may be made. In Fig. 21 A is a plate about 1 in. thick. A strickle runs over the edge of this plate and sweeps up the half core B on a plate. Figs. 22 and 23 show a plate which is, perhaps, more reliable. The strickle, which is C in Fig. 23, bears on both the inside and outside of the plate, and, of course, when the board is reversed the other half core can be made. A really good way of making a core is by means of an open frame like Fig. 24. End grounds are screwed on the frame and a strickle is guided by a strip. It is surprising that some foundries object to this form of plate, because it is its great advantage that there is no waiting while a half core is staved before the other half is proceeded with. The frame is laid on a plate, and when the core is made it is simply lifted over the core and the core can be run into the stave and another one proceeded with. There is less danger of this core frame altering in shape than a plate. If there is a branch core it can also be cut out of the frame unless it is not on the joint when a separate core will have to be made. Even if a separate core has to be made, however, it is not necessary to waste much time on the box. If it is a straight core clipping on to the body a square box like Figs. 25 and 26 should be made. If the core is 6 in. in diameter the inside of the box would be made 6 in. square. The ends or sides would be shaped to the same radius as the body. A straight length of core is dropped into the box, and the fitting shape strickled off with a straight edge or a special strickle.

With regard to the above open-frame method of making cores, if the foundry is beside the pattern-shop, instead of a runner like A in Fig. 28, the strickle may be made to work inside the frame. The method is illustrated in Fig. 31. The only

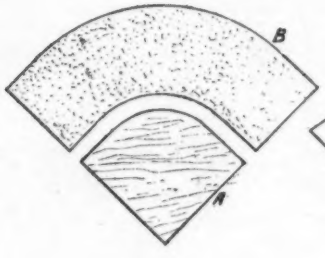


FIG. 21.

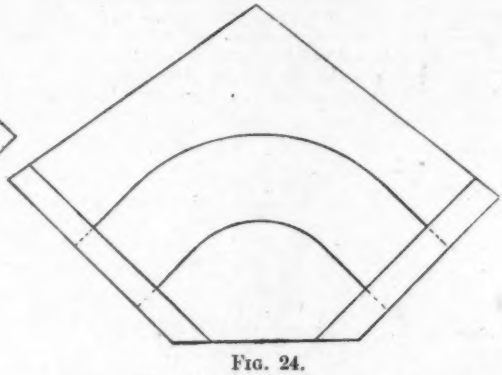


FIG. 24.

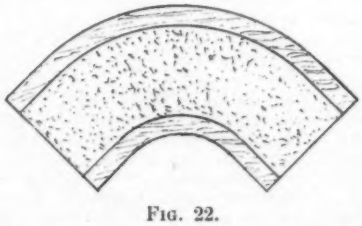


FIG. 22.

FIG. 23.

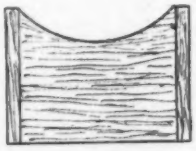


FIG. 25.

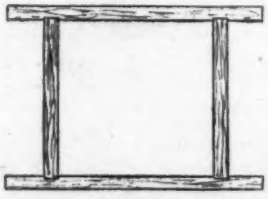


FIG. 26.

objection to this is the possibility of the coremaker carelessly making his core iron too large, or, in the event of the strickle being broken, a new one may be made to the wrong diameter. But if the foundry is at hand, and the work can be watched, it is a superior method, because it is not left to the coremaker to finish the core, which is left by the frame, shown in Fig. 28, with a square part the thickness of the plate as seen at A Fig. 30,

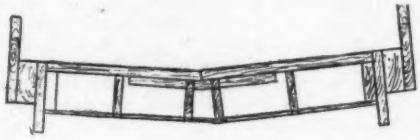


FIG. 29.

and it is much easier to lift the frame clear of the finished core.

For comparatively small pipes there is another way of making the core. The difficulty of making a frame for a pipe like Fig. 31 is readily seen. There is a break in the centre, and it would be necessary to reverse the frame for each half core. The simplest way—but a slow way— is to make the core on the joint of the pattern. Two circular

FIG. 30.

grounds have to be screwed to the prints and a strickle made running on the edge of the pattern. The strickle cannot be used across the flange, but the moulder can quickly make this up.

For a bend branch a frame may be made with a block screwed on the end, which is shaped like the main core. This is easily reversed for the other half core. (Figs. 27 and 28.)

The choice of the method of making the core

FIG. 32.

FIG. 33.

depends greatly on whether the foundry is near and can be easily visited. Undoubtedly this class of work gives great scope for the exercise of ingenuity in devising quick methods of working, both in making the templets and patterns and moulding them afterwards in the foundry.

It is not customary in this class of work to core bolt holes, but it is sometimes done. Fig. 32 shows one method, and Figs. 33 and 34 another and better method. In the first case a template the thickness of the flange is made and the cores are simply pressed into position. The objections to this method are obvious. Accuracy cannot be assured, and there is the danger that when the metal enters the mould the cores will move. In the second method the flange is made twice the required thickness, and the additional thickness is cored off with a box like Figs. 33 and 34. Either prints may be put into the box, so that the circular cores may

FIG. 27.

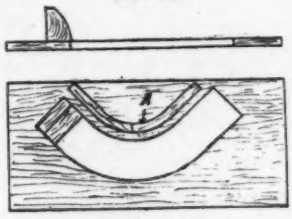


FIG. 28.

be fastened into them, or the bolt holes may be cut through the bottom of the box, which saves considerable trouble fastening small sores.

THOSE interested in the aircraft industry have been informed that the Inland Revenue authorities have agreed to allow 18 per cent. upon the invested capital to be retained before any charge is made in respect of excess war profits.

FIG. 31.

MACNAB & COMPANY.—Owing to a misprint in Messrs. MacNab & Company's advt. in our August issue, the output of their Tylor Patent Pit-Type Furnace was given as 200 lbs. of Admiralty gunmetal melted in 5 minutes. This should have read 25 minutes.

METAL TRADE RESEARCH ASSOCIATION. — A conference was held recently at Birmingham between Sir Frank Heath, of the Scientific Industrial Research

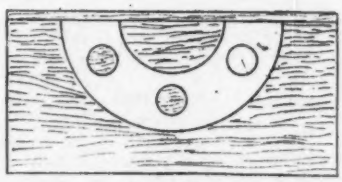


FIG. 34.

Council, and representatives of the non-ferrous metal trades, at which it was decided to set up a committee whose work should be to canvass the trades as far as possible and to get the utmost support that could be got to what might be called in its widest aspect a Trade Research Association. It was intended that those forming the Association should work together and collect the large amount of information in existence with regard to the very important alloys in which the metal trades are interested.

Thermal Refinement of Gear Blanks.

According to a Paper recently presented at the Convention of the American Gear Manufacturers' Association, by Mr. C. R. Poole, in the past few years great advance has been made in the heat-treating and hardening of gears. There are two distinct types of these, namely, carbonised and heat-treated. The difference between them is entirely in the carbon content, the carbon never running higher than 0.25 per cent. in the carburised type, while in the heat-treated gears the carbon is seldom lower than 0.35 per cent. The difference in the final gear is the hardness. The carburised gear is finished hard on the surface with a soft, tough and ductile core to withstand shock, while the heat-treated gear has a surface that can be touched by a file with a core of the same hardness as the outer surface.

Theoretically annealing should be accomplished at a temperature at just slightly above the critical point. However, in practice, the temperature is raised to a higher point in order to allow for the solution of the carbon and iron to be produced more rapidly as the time required to produce complete solution is reduced as the temperature increases past the critical point. Temperatures, exceeding the critical point by over 100 deg. Fah., should never be used on account of the enlargement of the grains of pearlite and ferrite. Microphotographs of a piece of steel annealed at temperatures increasing by 25 deg. from a point below the critical point to the burning point shows clearly the effects of temperature on the grain size.

For annealing the simpler types of low-carbon steels the following temperatures have been found to produce good machining conditions on account of producing uniform fine grain pearlite structure:—

(1) In the case of 1.15 to 0.25 per cent. carbon straight carbon steel, heat to 1,650 deg. Fah., and hold at this temperature until the work is uniformly heated, pull from the furnace and cool in air.

(2) In the case of 0.15 to 0.25 per cent. carbon 1½ per cent. nickel, one-half per cent. chromium steel, heat to 1,600 deg. Fah., and hold at this temperature until the work is uniformly heated, pull from the furnace and cool in air.

(3) In the case of 0.15 to 0.25 per cent. carbon 3½ per cent. nickel steel, heat to 1,575 deg. Fah., and hold at this temperature until the work is uniformly heated, pull from the furnace and cool in air.

In the annealing of the higher types of chrome-nickel steel, with the nickel content running about 3 per cent. and the chromium about 1 per cent. the operation is more difficult, as rapid cooling through the upper critical range produces a hardness due to the slight air hardening properties of steel of this composition. The annealing of this type of steel requires considerably more attention both in the heating and cooling. To produce the best machinability of this steel the following practice will give satisfactory results:—Heat to a temperature in excess of the critical point about 100 deg. Fah., holding at this temperature for a considerable time to allow for thorough heating and complete solution of the cementite; cool rapidly, either by pulling from the furnace into air or by opening the furnace doors, to a point at which the forgings show no colour in daylight; reheat to a point just in excess of the highest critical point and cool slowly in the furnace. The temperatures, length of heating, time and rate of cooling, are dependent on analysis, size of forging and weight of the load of forgings in the furnace.

With the steels used for the heat-treated gears always of a higher carbon content, treatment after forging is necessary for machining, as it would be impossible to get the required production from untreated forgings especially in the alloy steels. The treatment is more delicate, due to the higher percentage of carbon and the natural increase in cementite, together with complex carbides which are present in some of the higher types of alloys. Due to the many analyses of heat-treated gear steel it is impossible to give in this Paper specific treatments, but the general procedure is practically the same as for the case hardening of 3 per cent. nickel, 1 per cent. chromium steel given above. More time should be given to permit the complete solution to take place and the rate of cooling watched closely, together with the temperature at which the forgings are pulled from the furnace. For a furnace load weighing 550 lbs., of medium section forgings made from a steel of 0.50 per cent. carbon, 0.60 per cent. manganese, 3 per cent. nickel and 1 per cent. chromium, the following treatment gave good machining conditions on turning operations as well as on the gear shapers:—Heat to 1,330 deg. Fah., taking two hours to heat to the temperature. Hold at the temperature for 1½ hours and allow to cool in furnace to 1,170 deg. Fah., taking about one hour to cool. Reheat to 1,230 deg. Fah., consuming three-quarters of an hour to reheat. Hold at 1,230 deg. Fah. for 1¼ hours. Cool slowly in furnace, not faster than 75 deg. for the first hour, until 900 deg. Fah., then cool in air.

In the heat-treated steels poor machining conditions are present, generally due to incomplete solution of cementite rather than bands of free ferrite, as in the case of case-hardening steels. This segregation of carbon causes hard spots which, in the forming of the tooth, causes the cutter to ride over the hard metal, producing high spots on the face of the tooth which is as detrimental to satisfactory gear cutting as the drops or low spots produced on the face of the teeth when the pearlite is coarse-grained or in the banded condition.

The following gives a few of the hardening numerals on steel used in gear manufacture that produce good machining qualities:—

	Per cent.	Per cent.	Per cent.
Carbon	0.20	0.50	—
Nickel	3.00	3.00	—
Chromium	1.25	1.00	—
Carbon chrome-vanadium	—	—	0.50
Brinell test...	156–170	179–187	170–179

In the simpler carburised steels it is not necessary to test the forgings for hardness after the anneal, but with the high percentages of alloys in the carburising steels and the heat-treated steels a hardness test is essential. For this test the Brinell hardness tester is far more accurate than the scleroscope test. However, the Brinell test should not be used without the aid of the microscope. To obtain the best results in machining, the microstructure of the metal should be determined and a hardness range set that covers the variations in structure that produce good machining results. By careful control of the heat-treating operation and with the aid of the Brinell hardness tester and the microscope it is possible to obtain forgings that will machine uniformly and be soft enough to give the desired output.

National Physical Laboratory.

The Report, just to hand, of the Executive Committee of the National Physical Laboratory, for the year ended March 31 last, after a brief review of the history of the Laboratory reviews the events of the year 1917-1918 in greater detail. The report states, *inter alia*, that at the last meeting of the General Board, in June, 1917, the attention of the Board was mainly directed to the consideration of the future control and organisation of the Laboratory and its relations with the Committee of the Privy Council for Scientific and Industrial Research. The recommendations made at that meeting were accepted by the Research Committee, which has undertaken the responsibility for the finance of the Laboratory, leaving the control of its scientific work and researches, as heretofore, in the hands of the Royal Society. That control will be exercised, as in the past, through the General Board and the Executive Committee, and the representatives on the General Board of the great Technical Institutions will enable the Laboratory to maintain with them that close relationship which has proved so valuable and so essential to the success of the work. The terms of the modified scheme of organisation are printed as an Appendix to the Report of the Committee. The new scheme requires the presentation to the Research Department in December of each year of an annual report and programme of future work. It will thus be necessary in future to hold a meeting of the General Board in December. The Executive Committee suggest that this meeting should be held in London, and that the annual visitation of the Laboratory by members of the Board and others interested in its work should be held as at present in the month of June.

Some extensions of existing buildings have been made, or are in contemplation. The foundry in the Metallurgical Department has been doubled in size. An extension of the engineering shops is required, and additional accommodation is necessary in the Heat Department to provide facilities for the increasing number of tests of instruments of various types for high-temperature measurement.

The number of members of the staff now on service is forty-nine. Many of these joined up in August, 1914; twelve hold commissions, and eighteen others have received promotion to non-commissioned rank.

With regard to general engineering research, two reports on the methods of notched bar impact testing (being the third and fourth respectively) have been made to the Sub-Committee of the Engineering Standards Committee during the past year. As mentioned in the Laboratory Report of last year, it was decided by the Sub-Committee at the discussion of the second report that the effect of irregularity in the results of individual tests should be still further investigated, with the object of clearing up doubts on the following questions :—(1) Whether the irregularities commonly noted are inherent in the method of testing, *i.e.*, whether the manner of obtaining the work done in the fracture of the specimen by noting the height fallen through by the hammer before striking the specimen, and the height to which it rises after fracture is sufficiently accurate for the purpose. (2) Whether, on the other hand, these irregularities are due to want of homogeneity in the material. Thus a set of notched specimens might be identical as regards chemical composition, yet, owing to differences in the orientation of the crystalline structure at the bottom of the notch, widely different results might be obtained from the tests of them. As regards Question 1, it was anticipated that a definite answer would be obtained from the results of careful tests by different observers, in machines of different design, of specimens as nearly identical in composition and crystalline structure as could be obtained by careful selection and heat treatment. In the event of its being found impossible to obtain results comparable in regularity with those obtained in other mechanical tests, it was evident that existing doubts as to the value of the test would be strengthened. If, on the other hand, it could be definitely shown that the irregularities were due to want of homogeneity in the material, the value of the method as an instrument of research and as an acceptance test would be apparent. In the third report presented in June, 1917, the results obtained from specimens normalised and tested at the National Physical Laboratory were compared with the results obtained on specimens of the same material normalised and tested by other investigators. The broad conclusions drawn from the second and third reports as to the cause of the irregularities were :—(1) For ordinary low-carbon steels carefully normalised, the irregularities are sufficiently small to warrant the conclusion that the method of measuring the work of fracture is one of reasonable accuracy. (2) For high-carbon steels the irregularities were much more marked. For example, in three sets of ten specimens prepared from a 0.62 per cent. carbon steel normalised by Mr. Saniter, the average variations from the mean work of rupture were 12, 6 and 12 per cent. In view of the results of the tests on low-carbon specimens, it could only be assumed that the cause of the relatively greater irregularities in the high-carbon results was a want of homogeneity in the steel. It was then decided by the Sub-Committee that a special feature of the next series of tests should be the investigation of the effect of the root radius of shallow notched specimens in the detection of faulty heat treatment. For this purpose, a vee notch of 45 deg. was provisionally adopted, and the Laboratory was asked to make a series of tests on sets of specimens 10 x 10 x 53½ mm. with root radii of $\frac{3}{4}$ and $\frac{1}{4}$ mm. in :—(*a*) Ordinary commercial mild steel correctly and incorrectly heat treated. (*b*) High tensile steels correctly and incorrectly heat treated. The results obtained from these experiments and embodied in the fourth report to the Sub-Committee last February show very definitely that in order that faulty heat treatment in steels may be detected by tests on shallow notched specimens (2 mm. deep), it is essential that the root radius of the notch shall not exceed $\frac{1}{4}$ mm. For root radii larger than this the notch must be made deeper, as in the Charpy notch, which appears to be the most sensitive form for detecting faulty heat treatment, and in which, with a root radius of $\frac{3}{4}$ mm., the depth of the notch is 5 mm. As, however, the objections to the Charpy notch referred to in previous reports, *i.e.*, the difficulty of drilling a hole of 4-3 mm. diameter in the hard steels now commonly used in construction appear to be insuperable, the Sub-Committee are in favour of the standardisation of the shallow notched specimen. In the coming year it is proposed to make further investigations.

The Brinell ball hardness test is open to the objection that it varies with the load and with the size of ball used, consequently a standard ball of 10 mm. diameter and a fixed load of 3,000 kilos are employed. It is not always possible to use this standard (*e.g.*, for very thin test pieces or very soft materials) and various methods are adopted of bringing results obtained with different balls and loads into line with those obtained by using the standard. A series of experiments has been made with balls of different diameters, and it has been found that a hardness number can be obtained approximately independent of the ball diameter, by using the method suggested by Mr. Moore in a Paper to the International Association for Testing Materials, based on the conclusions of Meyer that, for the same material, the load divided by the area of the

indentation is constant for the same angle of indentation. Moore suggested that the angle should be such that the diameter of indentation was half the diameter of the ball used. For some purposes an impact indentation test has advantages. The ball is in contact with the material for such a short time that it is a convenient test to use for high temperature hardness tests; also, the effect of time of application of load has not to be considered, it being well-known that this affects the static hardness number and varies with different materials (the hardness number is constant for steel after about 15 to 30 seconds). A series of tests have been made to co-ordinate previous work on the subject. Martel had used a conical point as an indenting tool and Roos a 10 mm. ball. The former showed that with a point the energy of the blow was proportional to the volume of the indentation, and the latter that with a ball it was proportional to the square of the spherical area of the indentation. The tests made at the Laboratory confirm both experimenters.

An important development during the past year has been the determination of the effect of temperature on the fatigue ranges of stress of various materials. For this purpose one of the Wöhler fatigue machines has been adapted for testing specimens at steady temperatures up to 250 deg. C., by immersing the rotating specimen in an electrically heated bath of cotton-seed oil. Tests on an air-hardening nickel chrome steel showed that the fatigue range at 250 deg. C. was 20 per cent. lower than at normal temperature.

A number of samples of valve steel have been submitted for tensile and compression tests at high temperatures ranging between 650 and 950 deg. C. These were tested in the 10-ton Buckton vertical testing machine with a furnace consisting of a silica tube wound with platinum foil and capable of attaining a temperature of 1,000 deg. C. The temperature was measured by a platinum and platinum-iridium thermo-couple, connected to a Paul millivoltmeter graduated to read from 0 to 1,000 deg. C. by 10 deg., the couple being tied to the test piece so that the junction was at about the middle point. The tensile tests on six of the samples have been completed, the temperatures in each case approximating to 15, 650, 750, 850, 900 and 950 deg. C., and the results obtained are very interesting.

The following are abstracts from the Report on the Department of Metallurgy and Metallurgical Chemistry for the year, made by the Superintendent to the Director :—

The work on aluminium and other light alloys has been continued energetically throughout the year, and a large amount of research and investigatory test work on steel has been carried out, particularly in connection with boiler plates. Cases of failure in forgings, in boiler plates and boiler tubes and in other steel objects have been examined and reported upon.

Research work on magnetic steels has also been actively continued. A set of specially-made tungsten steels of graded composition has now been received from Messrs. Thos. Firth & Sons, Limited, of Sheffield, and their investigation has been begun. It has been found necessary to adopt better methods of magnetic measurement than those used in the earlier stages of the work, and special arrangements have also been adopted for carrying out thermal observations of these steels in a more satisfactory way. Their study from the magnetic point of view, both in the Laboratory and by earlier workers, has, however, revealed a number of discrepancies and difficulties; it is believed that these arise from the influence which the antecedent thermal and mechanical treatment of the steel exercises upon its subsequent magnetic behaviour. In order to clear up these important points which involve questions affecting other steels besides the particular tungsten alloys now being investigated, a special research has now been initiated for the study of the constitutional relations of iron-carbon-tungsten within the range of alloys concerned.

A considerable further amount of work has been carried out for the Steel Research Committee of the Institution of Automobile Engineers.

A number of inquiries concerning the hardening of steel for gauges, case-hardening of automobile parts, heat-treatment of sheet steel, and analogous questions, have been dealt with by correspondence, or by verbal consultation and demonstration.

The work in connection with the proposed issue of standardised steel samples to serve as standards for the chemical analysis of steels has been carried forward in conjunction with a Committee of the Iron and Steel Institute. It is hoped that the issue of standardised samples may become possible shortly.

Aluminium.

The Faraday Society.

Before the Faraday Society, on July 23, Mr. JOHN G. A. RHODIN read a Paper entitled "Contributions to the Chemistry of Aluminium and Aluminium Alloys," in which he dealt with the sorting of various kinds of scrap according to percentage of aluminium by means of direct determination of aluminium, soluble in 10 per cent. NaOH. The method was described in detail, and it was claimed for it that it allowed oxide to be determined as well. Certain phenomena relating to the behaviour of aluminium powder, when heated in air, were discussed, and also the preparation of Al_2O_3. A curve of specific gravities corresponding to percentages of aluminium in various alloys was given. Determination of specific heats was mentioned as an alternative.

In the discussion DR. W. ROSENHAIN said the presence of oxide in aluminium was of first-rate importance in substances like aluminium powder. Of two samples that looked alike, one might contain 20 to 30 per cent. of oxide. The appearance of the fractures in the samples shown suggested enclosures of foreign material rather than that the oxide was dissolved in the aluminium. He suggested the determination of melting-points as an alternative line of attack.

MR. CLAUDE T. J. VAUTIN submitted a new form of alumina, perfectly black, finely divided powder, containing 70 per cent. alumina and a small percentage of hydrate, which confirmed the author's statement as to the reduction of Al_2O_3 to a lower oxide.

DR. R. SELIGMAN found it difficult to accept the statement that caustic soda would dissolve the aluminium and leave undissolved the alumina supposed to be dissolved in that aluminium.

MR. C. N. WATERHOUSE suggested that the presence of the oxide considered by the author to be dissolved in aluminium might account for some of the contradictory results that had been obtained in experiments with aluminium and its alloys.

SIR ROBERT HADFIELD touched on the importance of aluminium to the steel-maker, and hoped that the author's study would enable them to get rid of the imperfections which were factors in preventing sound castings.

MR. ROBERT J. ANDERSON (Cleveland, U.S.A.) in a Paper entitled "Metallography of Aluminium: Recrystallisation and Grain-growth—the Result of Deformation in the Cold prior to Annealing," said that during some recent tests on the recrystallisation of cold-rolled aluminium sheet on annealing, some interesting recrystallisation and grain-growth phenomena were observed in this metal, which confirmed the general laws of grain-growth and recrystallisation as now understood. The results appeared to show definitely that aluminium was similar to other metals as regards annealing laws.

THE late Mr. L. Rusden, engineer, of Newcastle-on-Tyne, left £12,566.

Damascene Steel.*

By Colonel N. Belaiew, C.B. (London).

(1) Under the name of "damascene" or "Damascus" steel there appeared in Western Europe, during the Middle Ages, the same kind of celebrated Indian steel which was already known in Russia as "poulad" or "bulat."

(2) The external characteristic of this steel was its patterned surface-watering, or "jauher" (Persian); therefore the Persians called such steel "poulad jauherder," which means "steel with a watered surface." This steel was imported into Russia through Persia and the Caucasus, and became known from the sixteenth century as "poulad" or "bulat"; the same steel found its way to Western Europe through Syria and Palestine as damascene or Damascus steel.

(3) The damascene steel was manufactured in India, and apparently this manufacture afterwards spread to some parts of the Iran; the origin of the process may be traced back many centuries B.C. According to the author's researches, there were at least three principal methods of producing this steel:—(*a*) The old Indian, which consisted of producing crucible steel from pure ore and the best kind of charcoal; (*b*) the Persian, when the charge was pure soft iron and graphite, and (*c*) a certain heat treatment, like a very prolonged tempering; this third process is considered by Anossoff as a kind of "refining process."

(4) During the melting process the greatest care was given to its intensity and duration; both the Oriental writers and Anossoff pointed out that the best watering could be obtained only on alloys which were kept as long as possible in a molten state and then allowed to cool down gradually with the furnace. When cold, the crucible was opened, and the damascene alloy found in the shape of a cake.

(5) Such cakes were described by Tavernier and others, and were brought to this country by Dr. Scott. They gave rise to many investigations, notably those of Stodart and Faraday in England, Réaumur and Bréant in France, and Anossoff in Russia. Besides their first object (the study of the damascene process) these experiments paved the way for many fruitful investigations. Stodart and Faraday, trying to discover the origin of the watering, made a series of experiments on the alloys of iron with nickel, copper, gold, and platinum; Bréant, by the same study of damascene alloys, made a classification of steels according to their carbon content, very much on our modern lines; finally, Anossoff, among many other valuable observations on the mechanical and heat treatment of steel in conjunction with its structure, as appearing on its polished and etched surface, began regularly to apply the microscope, as early as 1831, to the study of all his alloys from the point of view of their industrial properties and applications.

(6) Anossoff's classification of the patterns of damascene blades is given in the Paper. In proportion to the carbon percentage, this changes from parallel stripes into wavy ones, then to mottled, and, finally, to vertebræ: this latter is considered the most perfect; its Persian name is "kirk nardubán," or forty steps of Mahomet's ladder. Anossoff's views as to the shade of the background and the lustre are also given, and the mechanical properties of some of his articles are described.

(7) Professor Tchernoff's view that "the best kind of steel ever manufactured was undoubtedly the bulat" is quoted, and the author's researches on damascene steel and his systematic experiments at Putiloff and other steelworks are described; it is pointed out that alloys slowly cooled down with the furnace will develop in a marked degree both the crystallisations from the fluid state—the primary crystallisation and the secondary; in the case of hypereutectoid alloys the separation of the excess cementite will follow the dendritic axes, so giving place to "the structure of large crystals." This structure is typified by the complete identity of the pictures of the primary and secondary crystallisations, the deposits of cementite following pretty closely the dendritic axes. This structure is the more developed the higher the carbon content; alloys from 1.2-1.5 to 1.80 are especially apt to develop it.

(8) The author's analyses of damascene blades are given, showing that these usually range between 1.10 to 1.80 carbon; the life-history of a typical damascene alloy of 1.5 per cent. is further given. Such alloy, after its solidification as a cake, will show in its cross section "the structure of large crystals"; after forging, the straight lines of the axes and branches will gradually alter to the wavy or motley watering described by Anossoff; this watering, when examined with the naked eye, represents the macrostructure of the finished article, and shows, besides the properties of the original alloy, the way in which the article has been forged, *i.e.*, its mechanical treatment; attention is urged to this important point.

(9) The ductility of damascene alloys is further discussed, and the observations of Howe and Arnou mentioned; it is observed, however, that while both the melting process and the method of cooling are in a certain degree responsible for the malleability of the damask, the real explanation is found in the microstructure of the finished article. The "milky ways" of the cementite particles, into which every line of the watering gradually dissolves as higher magnification is applied, are described, and the "spherodising" of the iron carbide dealt with. It is remarked how the cracks and brittleness of hypereutectoid steels with their pike- or needle-form excess cementite are avoided in the damascene steel, where the same amount of cementite is embedded in the ground-mass in the form of small, round-shaped globulites. The refining of damascene steel is described, and the experiments of Anossoff, as well as more modern ones, are given; further heat treatments of damascene articles are briefly mentioned.

(10) Finally, the author wishes to draw the attention of those interested in tool steel to the damascene steel; its malleability and elasticity and, last, but not least, to its splendid watering, or, as we should say nowadays, its macrostructure, which gives such a perfect record of the life-history of the finished article, both with regard to its mechanical and heat treatment.

Just before the war broke out the author began a series of investigations on the famous collection of Eastern swords in the Imperial Hermitage at Petrograd, always bearing in mind Anossoff's wish, "that damascene steel will supersede any other steel now employed for the manufacture of articles of special sharpness and endurance." Unable to complete these researches, the author nevertheless hopes that his Paper may again arouse in this country an interest in damascene steel, and that a further step towards the fulfilment of Anossoff's wishes may thus be achieved.

* Summary of paper read before the Iron and Steel Institute, May, 1918

Brass Industry Combine.

Mr. Howard F. Smith (of Messrs. Smith & Davis, Limited, Birmingham) recently published a pamphlet under the title of "Syndication in the Brass Industry," which is intended to serve as a basis of further discussion. The author, in his foreword, points out that for the manufacturing world to progress there must always be a continual striving to produce cheaper and better. Price maintenance, however, does not encourage the necessary energy and initiative to progress.

The advantages of combination are quite apparent, but the stumbling block is—the method to be adopted to bring about the end in view. The division or re-shuffling of our resources so that we can concentrate on perhaps no more than 25 per cent. of the lines produced before the war will give cheaper production, bigger profits, and better wages.

As a product has to be made before it is sold the question of production must come before that of distribution. The class of material therefore must be the basis of all production. In the case of brass, as the trade is at present constituted this divides itself into three main classes:—Cast, sheet and rod, and each of these three main classes requires distinct methods of working the raw material. Such a division would ultimately result in greater economy of manufacture and greater production within the combine than any other so far suggested.

In order to arrive at a satisfactory division of effort, the firms desirous of combining should be asked to specify clearly what branch of the industry they wish to specialise in, certain records being made of their resources in plant and machinery; with separate records of the plant and machinery they would be prepared to hand over to other firms in the combine in exchange for plant and machinery more suited to their future needs.

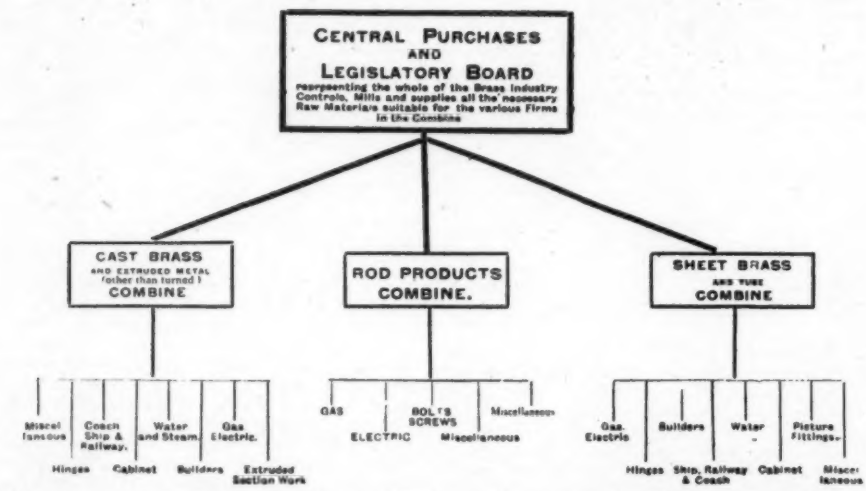
The firms in each of the three main divisions would then form themselves into separate and distinct combines for both production and distribution, and each combine would be so constituted that it would conduct all important matters of business for the firms in its own jurisdiction, with the exception of the purchasing of raw material and certain legislatory matters which would be done by a Central Purchases and Legislatory Board, supported jointly by each of the combines.

The annexed chart will give a clear idea as to the proposed sub-division in the matter of production. Each combine, as will be seen, is divided into sections according to the class of trades the firms would operate in.

Each combine would make its own sections, and certain sections (or trades) would be duplicated or even triplicated by being represented in each of the combines, whilst other trades would be peculiar to but one of the combines only. If it is feared that misunderstandings might at a later date occur with firms entering the market with competitive articles which are neither cast, sheet metal or rodding, it is easy to state at the commencement what combine certain classes of raw material will naturally fall into.

Considering the section which comprises all classes of products made from rodding, after making the sections that cater for certain branches of trade, it may be found that two or three firms are left in each section, and therefore in order to prevent wasteful overlapping, one firm could specialise on all those products made from rod below ¾ in. on automatic feed machines, whilst another would handle ordinary hand-operated capstan lathe work below ¾ in., and still another firm could handle everything above ¾ in. In this way we should get as near intensive production as possible, and instead of having a factory filled with every conceivable size and type of machine, and having to employ a variety of experts, both for tool setting and tool designing, we should save considerable expense in the specialisation that would accrue.

Costings and the necessary elaboration of works accounts is the next subject that should receive attention by the firms in each combine, and their accumulated knowledge coupled with the services of an up-to-date firm of accountants, should be brought to bear on the matter and a system devised that in its main principles would be satisfactory for each firm in the combine.



As regards distribution and selling it is understood that there is no desire to cut out the distributing trade. What however is to be avoided is the spectacle of half a dozen or more travellers visiting the same town in the same month, and offering the same patterns to the same buyers. A lamentable waste of energy at present. For each of the combines therefore the author would suggest pooling the selling effort of the individual manufacturers and then dividing the whole of the United Kingdom into a number of sections, according to the size and importance of the combinations. At each centre he would establish permanent offices and showrooms, with a head salesman or sales manager in charge, with as many under-salesmen as are deemed necessary to cover the ground.

In connection with overseas business the author would recommend that the methods outlined for the home trade be carried out in populated territories, but in poorly populated countries it might be found desirable to have special arrangements with the allied combines in the industry, whereby they would support collectively selling offices and showroms in certain centres.

The method of re-construction of the trade as laid down in the pamphlet would require first of all a pooling of capital, either total, 75 per cent. or 51 per cent. basis, but in any case not less than the last-mentioned percentage, as if the principles of combination be adopted it would only be in keeping with the whole scheme to give the control over to the combine. The author mentions 51 per cent. because he thinks the arrangement would allow sufficient interest to cultivate that push-and-go which is so necessary with all firms in the combine, whereas a 75 per cent., and especially a 100 per cent. margin, would give little inducement for the cultivation of initiative and individuality. The firms, it is supposed, would be admitted to the combine on a valuation of existing plant, etc., combined with a valuation of the profits for a certain period of years, due note being taken of the latter, and the rate of progress year by year on the profit earning capacity of the business, and allowances accordingly made on an agreed principle.

The form of representation of the firms on the executive of each combine would be an important point to be decided, and this largely depends on the number of businesses who associate themselves. If more than a dozen firms join the combine it may be found desirable to limit the number of representatives on the council, otherwise it would be unwieldy. Reports of all proceedings would be circulated among the associated firms.

The constitution of the Central Board should include elected representatives from each combine, and in order to make the whole scheme self-contained and self-supporting the author would also suggest that a sufficiency of metal merchants and metal rollers be invited to join, who would of course have to merge their interests in exactly the same manner as the rest of the firms, and, giving up their individuality to the extent of at least 51 per cent., become part and parcel of the Control Board of the three combines.

Further suggestions in the pamphlet relate, among others, to the question of technical training, apprenticeship, etc. Copies may be obtained upon application addressed to the author at 7, Hampton Street, Birmingham.

A second edition of the pamphlet has since been issued, and contains some further observations by the author, together with comments and criticisms from the trade and technical Press and various members of the brass industry, among whom the first edition seems to have created a considerable amount of interest.

Post-War Priority.

The Minister of Reconstruction appointed last year a Committee of the Council of the Ministry, under the chairmanship of Sir Henry Birchenough, to consider the principles upon upon which, in the event of a shortage of the necessary supplies for industry after the war, such things should be rationed, and to report upon the machinery requisite for the purpose. The Committee have now presented their Report, and while advising that control should be discontinued at as early a date as possible, and that in the meantime there should be the least possible interference with private enterprise, they have made recommendations as to the principles and machinery for allocation and priority after the war in cases where it is found to be imperative.

The Committee recommend that special consideration should be given to industries which provided a large measure of employment, and that importance should be attached primarily to industries connected with :—(1) The production of food and raw materials; (2) the manufacture of machinery and equipment which are immediately necessary for the industrial and transport requirements of the country; (3) the manufacture of finished goods for export; (4) the production of goods for home requirements of a pressing nature. Detailed recommendations are also made by the Committee as to the machinery to direct allocation and relative priority.

The proposals of the Committee have been carefully considered by the Government, which, after consultation with the Departments principally concerned, has decided to take immediate action on the lines of the Committee's Report and the recommendations of the Minister of Reconstruction It is the intention of the Government that post-war control and allocation of materials shall be applied only in cases where it is absolutely necessary. On the assumption, however, that of certain commodities there will be a shortage which will render some form of control imperative. arrangements require to be made for dealing with the matter.

It is proposed that a small Cabinet Committee on Post-War Priority shall be set up, consisting of the President of the Board of Trade, the Minister of Labour, the Minister of Shipping, the Minister of Munitions, and the Minister of Reconstruction, with the same chairman as the War Priorities Committee. This Committee will determine large questions of policy and will lay down the general principles upon which any allocation and priority should proceed where necessary.

Secondly, this Cabinet Committee will be assisted by a Standing Council composed of members of the Departments chiefly concerned, together with persons representative of commerce, industry, and labour. These two bodies will form the central machinery, and will, of course, be in close touch with the existing War Priorities Committee.

It is hoped that by the foregoing decisions adequate arrangements, convenient to the needs of civil industries, will be secured for dealing with such questions of control, allocation, and priority as may arise after the war

EXTENSIVE damage has been done by a fire at the engineering works of George Clark, Limited, Sunderland.

Test-Piece Preparing Machine.

In every steel works and in most engineering shops suitable means for physical testing of material are a necessary part of the equipment; generally speaking, however, there are no special facilities for preparing the test-pieces, and where testing has to be done on an extensive scale such preparation is a lengthy process and involves a considerable amount of labour. We illustrate a test-piece preparing machine made by the Hurd Coalcutter & Engineering Company, Limited, Glasgow. As will be seen, it is of particularly rigid construction. The blanks from which the pieces are to be prepared are placed in a frame which is mounted on the slide rest and travels between the two revolving chucks shown, thus machining both sides at once. The chucks, which each carry eight tools, can be adjusted horizontally so as to permit of machining to correct width, and are normally arranged for removing 10 in. of metal, each chuck being positively driven through machine-cut gear. The frame is arranged to take blanks up to 21½ in. in length, and 2 in. or more in breadth, all packed together to form a depth of 12 in. and held in the frame by set screws. The normal time required to prepare twenty-four ½-in. thick test-pieces, or equal, is from 35 to 40 minutes. A cone-pulley drive is provided for the feed motion, so that the speed of feed may be altered to meet varying conditions. The machine illustrated is driven by a 10-h.p. motor the whole occupying a floor space of 12 ft. by 7 ft.

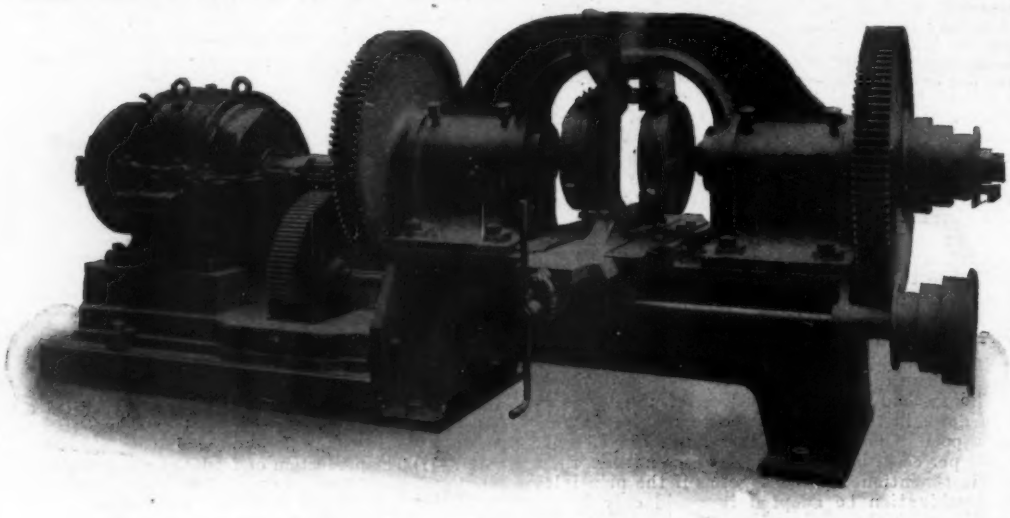


FIG. 1.—GENERAL VIEW OF TEST-PIECE PREPARING MACHINE.

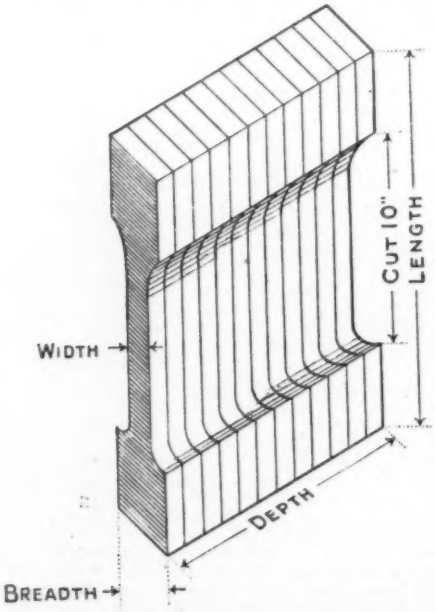


FIG. 2.—MACHINED TEST-PIECES PACKED TOGETHER.

ACID-RESISTING CAPACITY OF FERRO-SILICON ALLOYS.—M. Camille Matignon, in a recent issue of "Comptes Rendus," gives the results of some corrosion tests conducted in 1913 on various ferro-silicon alloys containing 13-17 per cent. of silicon, nearly 1 per cent. of manganese, and traces of phosphorus and sulphur. Various other compositions were also investigated, including ferro-boron. The tests were made in boiling nitric acid and in boiling mixtures of acetic and butyric acids, both concentrated and diluted, the tests being in some cases continued for 360 hours. Ferro-boron was easily attacked, and none of the alloys resisted hydrochloric acid.

THE original ordinary share capital of the Atlas Steel Foundry Company, Limited, of £25,000 has been increased to £75,000 with a view to pushing forward the extension scheme which has been approved by the Ministry of Munitions.

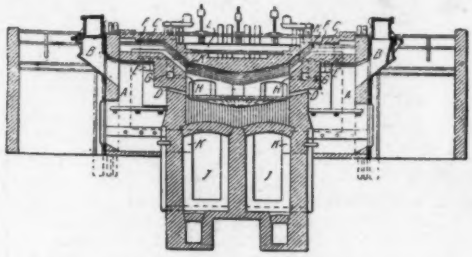
An Improved Bundling Press.

The new design of improved hand bundling press introduced by Messrs. Hollings & Guest, Limited, of Thimble Mill Lane, Birmingham, which we illustrate herewith, is of interest to users of baling machines. In it the makers have fixed a quicker method of operation by means of a toothed rack and pinion which incorporates a release, enabling the plunger to be either dropped or wound down to its work very rapidly. A

substantial saving of time is thereby effected, and this feature, together with the quicker return action and the new design of crosshead, which is now fixed instead of movable, combines to make the press very quick in working and rigid in construction. As before, the press is strongly constructed of steel plates, reinforced where necessary, and should be found powerful, handy and reliable, and capable of giving excellent service wherever there is anything baleable.

Open-Hearth Furnace for Light Castings.

Annexed illustration shows the longitudinal section of an open-hearth furnace recently designed by Herr Edwin Bosshardt, of Berlin, for producing metal suitable for light steel and malleable castings, the latter with carbon content as low as 0.1 per cent. It comprises two gas producers A and A, which are fed through the hoppers B and B, and deliver gas for the furnace through C and C. A special feature of the invention are the slits D and D, which admit the flames from each producer hearth to the furnace, and ensure a ready ignition of the gas and a high temperature in the furnace. The producer gas itself passes through the flues E and E into the containers F and F, each fitted with a reversing valve, and thence through the flues G and G, in which it is preheated, through other slits H and H into the furnace. As regards the air supply this is preheated in chambers J and J in the usual way, and enters the furnace through the openings K and K. The two gas generators are connected by a pipe L so that when the gas is reversed, the producer that is cut off delivers its gas through pipe L to the other generator's container F. It is claimed that a temperature as high as 2,000 deg. C. can be produced in this furnace, and that, consequently, solid material, like crop ends of rails, old fish-plates, shearings from boiler plates, etc., can be charged into the furnace and readily melted down, and the carbon content of the metal can be reduced to an unusually low point, producing a metal with an ultimate tensile strength of 22.86 to 26.67 tons per sq. in. with an extension of 28 to 32 per cent. The distance apart of the pop marks is not stated. The capacity of the furnace is about 2 metric tons, and a basic lining is used if the usual scrap of engine



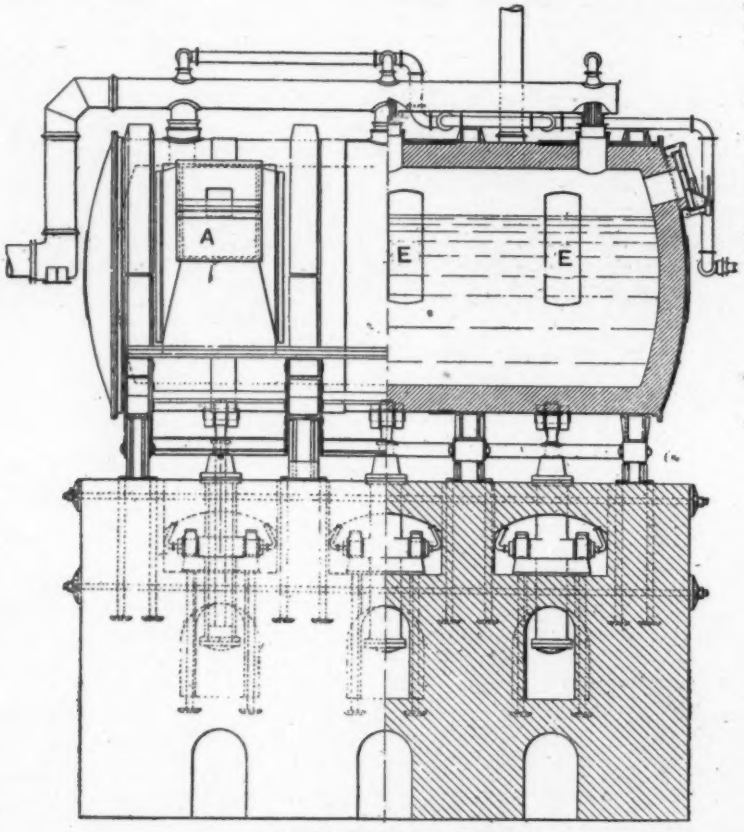
Open-hearth Furnace for Light Castings.

and shipbuilding works is to be utilised. The melting of the charge takes about 70 min., and the furnace can be tapped after another 50 min. As the metal is brought to a very fluid state, it can be poured quickly, which means no trouble with ferro-alloys or waste. It is stated that the furnace can be worked for three months without repairs, when only the heads have to be renewed, which will take from six to eight days. The roof will last out about three pairs of new heads. The fuel consumption of the furnace is stated to be 1 lb. of coal to 1 lb. of scrap, etc., with two charges per day; this rate, however, can be reduced to about ½ lb. of coal to 1 lb. of scrap, etc., with four meltings per day.

BRITISH-MADE LABORATORY APPARATUS.—Prior to the war practically the whole of the chemical laboratory apparatus was imported from Germany, one of the principal agents for its sale in this country being Messrs. Stanley Belcher & Mason, Limited, Church Street, Birmingham. With the outbreak of war there was, of course, an immediate increase in the demand for such apparatus, and to meet it with the foreign supplies cut off was a serious proposition. It was not only a question of evolving a suitable composition of glass, but also of devising new and adapting existing machines to the particular requirements and training a staff specially for the work. The result of Messrs. Stanley Belcher & Mason's enterprise is a small but particularly well equipped works. In the first place a composition was evolved to take the place of the Jena glass; the company then embarked on the production of beakers, etc., and cylinders and other accessories for graduating instruments. The manufacture of these articles was first conducted on an experimental scale in Birmingham, and the perfection of the products thoroughly established. As a matter of fact, the glass may be heated up to 190 deg. C. and be dropped into cold water without damage. The manufacture of the glass was then transferred to the north, and the equipment of the Church Street works started by the company, where all calibrating, etching and finishing is carried out.

A 1,400-Ton Metal Mixer.

The annexed cut shows a mixer of a capacity of 1,400 tons of hot metal recently erected at the works of the Lothringer Hütten-Verein Aumetz-Friede (formerly a Belgian, now a German concern) at Kneuttingen, and described in a recent issue of "Stahl und Eisen." The outside shell, which is cylindrical in shape, has an inside diameter of 20 ft. 8 in., and is about 41 ft. long. The shell is bound on the outside by four complete cast-steel rings, which rest on four sets of roller-bearings, the rollers being of forged steel. The race itself is built up of mild steel.



1,400-Ton Metal Mixer.

The mixer is actuated by three hydraulic rams having a stroke of nearly 11 ft. In order to save water under pressure when the power is not required, the inlets to the rams are so arranged that one or two of the cylinders can be filled with water from the common supply, while the other two, or the third cylinder—as the case may be—can be filled from the accumulator with water under a pressure of about 1,100 lbs. per sq. in. The mixer is bedded eccentrically, so that in case of a burst pipe or any other cause of failure in the pressure, the mixer drops back automatically into its normal position.

To heat the mixer and to maintain the temperature of the slag three burners are provided, using air from the blower and blast-furnace gas. Provision has also been made for oil firing at the ends.

The metal is poured in at two fillers, E and E, the lids of which are lifted by electric winches. The pouring spout is shown at A. No special provision has been made for drawing off the slag.

ELECTRIC STEEL CASTINGS.—Mr. R. F. Flinterman, in a recent Paper submitted to the American Electro-Chemical Society on "Electric Steel Castings," stated that his firm, the Michigan Steel Castings Company, of Detroit, U.S.A., are furnishing considerable quantities of castings to U.S. Army specification for class No. 2 steel, and to U.S. Navy specification for Class B steel, which not only pass the specified tests, but give even better tests regularly. Thus the Army specification named calls for an ultimate strength of 75,000 lbs. per sq. in., an elastic limit of 35,000 lbs., with 15 per cent. elongation in 2 in. and 20 per cent. reduction in area; the tests actually obtained are 75,000 lbs., 40,000 lbs., 20 per cent. and 30 per cent. The Navy specification calls for 60,000 lbs. ultimate, 27,000 lbs. elastic limit, with 22 per cent. elongation and 30 per cent. contraction, the tests actually obtained being 65,000 lbs., 35,000 lbs., 30 per cent. and 40 per cent. respectively. Bending tests give up to 170 and 180 deg. instead of the specified 120 deg. The heats are held for analysis before pouring, and every effort is made to get the exact carbon and manganese content.

Trade Talk.

A PETITION for the winding up of the Friction Bearing Metal Company, Limited, will be heard in London, on October 15.

THE GENERAL IRON AND HARDWARE COMPANY, LIMITED, is being wound up voluntarily, with Mr. A. M. Shaw, Glasgow, liquidator.

EXTENSIVE damage was was done on August 23 by a fire at the premises of W. Canning & Company, engineers, of Snow Hill, Birmingham.

THE UNIVERSAL MACHINERY COMPANY (LEEDS), LIMITED, is being wound up voluntarily, with Mr. J. Gordon, Bond Place, Leeds, as liquidator.

THE London offices of Penman & Company, Limited, Caledonian Ironworks, Glasgow, have been removed to Suffolk House, Laurence Pountney Hill, E.C.4.

A RECEIVING ORDER has been made in connection with the affairs of J. Onions, who traded as the Vane Street Engineering Company, Vane Street, Wolverhampton.

WEST SPRINGS, LIMITED, have opened a London office at 5, London-wall Buildings, E.C.2. Mr. E. Shephard has been appointed secretary of the London committee.

THE HASLAM FOUNDRY & ENGINEERING COMPANY Derby, have just celebrated their jubilee. The concern was established by Sir Alfred Scale Haslam in 1868.

THE Board of Trade propose to take possession, through the Controller of Timber Supplies, of all descriptions of sawn and planed softwood (excluding box shooks).

BLAST FURNACES & EQUIPMENT, LIMITED, have removed their offices from 25, Victoria Street, Westminster, London, S.W.1, to 105, Colmore Row, Birmingham.

MESSRS. J. GILL and P. D. MILLS, carrying on business as brass founders, George Street, Walsall, under the style of the George Street Foundry, have dissolved partnership.

FOR the purposes of reconstruction, Brown, Bayley's Steel Works, Limited, are being wound up voluntarily. Mr. H. Ashford ,39, Waterloo Street, Birmingham, has been appointed liquidator.

FRYS (LONDON), LIMITED, tool and hardware merchants, 46, Upper Thames Street, London, E.C.4, have appointed Mr. W. H. Moss, 21, Sholebroke Place, Chapeltown Road, Leeds, as their Yorkshire agent.

THE extensive new works which are being built at Levenshulme, Manchester, for Crossley Motors, Limited, are nearing completion. The company have already entered into occupation of some portions of the buildings.

THE Manchester Metal Merchants' Association will, in future, be known as the Lancashire and Yorkshire Iron, Steel, Tinplate, and Metal Stockholders' Association. The association is affiliated with the Merchants' Federation.

MESSRS. ELTON, LEVY & COMPANY, metal merchants and brokers, Creechurch Lane, Leadenhall Street, London, E.C.3, have acquired the metal refining business carried on at the Park Road Metal Works, Park Road, Hockley, Birmingham.

MESSRS. R. NESBIT and G. E. SEYMOUR, engineers and contractors, 34, Dean Street, Newcastle-upon-Tyne, trading under the style of Seymour & Nesbit, have dissolved partnership. The business will be continued by Mr. G. E. Seymour, as G. E. Seymour & Company.

JOHN I. THORNYCROFT & COMPANY, LIMITED, shipbuilders and engineers, have notified us that in consequence of the Government having commandeered their offices at Caxton House, Westminster, they are removing to new offices at 10, Grosvenor Place, London, S.W.1.

FOR the purposes of reconstruction the Flottmann Engineering Company, Limited, is being wound up voluntarily, with Mr. W. J. Wilson, 60, St. James's Street, London, S.W.1, as liquidator. The new company will be named the British Flottmann Drill Company, Limited.

THE FELLOWS MAGNETO COMPANY, LIMITED, for the purpose of financing the recent and prospective expansion of the company's undertakings, are authorised by the Treasury to issue £40,000 of fresh capital in the form of 8 per cent. cumulative participating preferred shares at par.

PERKINS ENGINEERS, LIMITED, Westwood Works, Peterborough, have disposed of their business to Werner, Pfleiderer & Perkins, Limited. The company are, accordingly, being wound up voluntarily, with Mr. J. Newman, Westwood Works, Peterborough, as liquidator. The style of the combined businesses will be Perkins Engineers, Limited.

ORDERS were made on August 8 restoring the letters patent granted to H. Rudman, H. T. Lancey and J. E. H. Craven for inventions entitled "Improvements in and relating to foundry moulding boxes" numbered 15,101 of 1913, and "Improvements in and relating to hand-operated moulding machines for foundry use" numbered 15,102 of 1913.

THE business carried on by Messrs. Crookes, Roberts & Company, at the Argos Works, Shoreham Street, Sheffield, as engineers' tools, saw, and steel manufacturers, has been purchased by Mr. Wm. Jas. Ritchie, trading as W. J. Ritchie & Company, of Freedom Works, John Street, Sheffield. The business will be continued by Mr. Ritchie under the old name of Crookes, Roberts & Company at the Argos Works on his own account, and as an entirely separate business from W. J. Ritchie & Company.

THE INDUSTRIAL RECONSTRUCTION COUNCIL, which aims at a general adoption of the principle of "self-government for industry," has arranged a series of fortnightly lectures to be given at the Saddlers' Hall, Cheapside, beginning on October 2, when Sir Albert Stanley, M.P., will speak on "Commerce and Industry after the War." Dr. Addison, M.P., will deal on October 16 with "Principles of Reconstruction," Mr. W. L. Hichens on October 30 with "Functions of the Government in Relation to Industry," and Sir A. Steel-Maitland, M.P., on November 13.

MR. H. A. BLACKWELL, chairman of George G. Blackwell, Sons & Company, Limited, of Liverpool, has established works at San Querico, Genoa, for the manufacture of ferro-tungsten and other alloys by his process. The business carried on under the style of George G. Blackwell, Sons & Company, Stabilimenti Metallurgici, the head office being at Via San Luca, 1-8, Genoa. The director-general of the company is Mr. Furio Viola, while the technical direction is undertaken by Mr. B. H. Rolfe, hitherto managing director of Etablissements Metallurgiques George G. Blackwell Fils & Cie., Soc. Anon., the French branch of Messrs. Blackwell's business.

THE new company has been registered in connection with the rearrangement of the capital of Brown Bayley's Steel Works. It was decided to exchange four new ordinary shares of £5 each for each of the old £10 paid shares, and two new shares for each of the old £5 paid shares. The issue of £300,000 5 per cent. cumulatave preference shares at par was also contemplated. The authorised capital of the new company is £800,000, of which £500,000 is in preference and £300,000 in ordinary shares, all of £5 each. The first directors are Mr. R. Armitage, M.P., Major J. W. Armitage, Lord E. Hamilton, Mr. H. Brearley, and Mr. R. Mainprice.

A NUMBER of representatives of trade, commerce, and industry, and of industrial organisations established under the Whitley scheme attended a private conference with Dr. Addison, the Minister of Reconstruction, last month, to hear the Government's proposals with regard to a system of priority and allocation of raw materials during the transitional period after the war. This question was referred by the Minister of Reconstruction early this year to Section II. of his Advisory Council. This committee drew up a report, and an outline scheme based upon its recommendations was presented by the Ministry of

Reconstruction to the Government, by whom it was approved.

With reference to an official notice that appeared in the Press on August 1 respecting the issue of licences under the Non-Ferrous Metal Industry Act, the Board of Trade desire to make it clear that applications for licences may be made at any time, and will be considered in the order in which they are received. But the extension of time referred to in the notice, allowing persons to continue to trade without licence, applies only to those whose applications had been received by August 5. Persons making application after that date will not be able to carry on business as defined in the rules in the metals and ores to which the Act applies, unless and until they have received a licence.

A group of large firms engaged in the principal industries of the Manchester district have offered to the governing body of the Manchester College of Technology the sum of £3,000, spread over a period of five years, towards the cost of establishing a new department of industrial management, and this has been accepted by the Manchester City Council. A lecturer will shortly be appointed for this period of five years to conduct research in the subject of industrial management, to organise a new department, to lecture to members of the college and to the public, and to assist industrial concerns in the solution of management problems.

It has been represented to the Controller of Timber Supplies that merchants, to whom rations from the national stock have been allocated, are in some cases refusing to accept orders from consumers, with a view to distributing their allotments among their various customers, or otherwise holding it back from purchase by persons holding permits. The Controller points out that merchants are now acting in effect as distributors of the national stock, and that failure to supply holders of permits, where unsold rations are available, can only result in injury to the national interests, as well as to those of the timber trade. Refusal to sell to a permit holder on the part of a merchant able to supply would afford ground for the withdrawal of the merchant's ration. In the event of undue delay by the trade in the supply of timber to a customer holding a permit, the Controller might find it necessary to supply direct from the national stock.

Sir Hugh Bell, in an address on Employers and Employed, delivered before the Welfare Conference at Oxford, said the problem which presented itself to him was as to the division of the product of industry. Referring to the iron and steel industry, he pointed out that, beginning as he did with the raw material, he was able to make a complete analysis of the whole division of profits, with the result that wages formed 70 per cent. of the whole, salaries 5 per cent., and the remaining 25 per cent. served to pay all other outgoings and to provide his profit, which at the most did not exceed 10 per cent. Of this not more than half was available for his own use. From the remaining half of the employer's share any improvement in the works and plant had to be provided. Improvement in the standard of living of the workpeople could be best accomplished not by the reapportionment of the product of industry, but by the enhancement of its amount.

In the circular of March 15 last, addressed to the shareholders of Fraser & Chalmers, Limited, a preliminary statement was made regarding the negotiations then in hand with the General Electric Company, Limited, for the sale of the Erith works, together with the manufacturing business and the goodwill attaching thereto, excepting the mining machinery business. The retention of the mining machinery business was found, on drafting the sale agreement, to present so many difficulties in definition that a modification of the whole basis of the sale had to be adopted. The agreement, which is now completed, provides for the transfer to the General Electric Company, Limited, of the entire works of Fraser & Chalmers, Limited, at Erith, and all the manufactures hitherto conducted therein, together with the goodwill. The increased amount now payable in respect of goodwill, patents, patterns and drawings, which do not appear as assets in the company's balance-sheet, is fixed at £110,000.

A Parliamentary White Paper has been issued on the subject of income tax allowances for depreciation and obsolescence of plant and machinery. Several new features of interest are included as being changes in procedure, and allowance provided in these respects by the Finance Act, 1918. For instance, in cases affecting a class of trade or business, the question of the amount allowable for "wear and tear" may now be carried by appeal from the Income Tax Commissioners to the Board of Referees. Allowances are continued for renewals of machinery, and in the computation of his profits for assessment under Schedule D, a trader is allowed to deduct, as a trade expense, his whole outlay on repairs and maintenance and insurance of his trade premises, is allowed tax free a sum equal to one-sixth of the annual value of the mill or factory to provide a sinking fund to replace the building. Full depreciation is allowed for machinery or plant temporarily out of use through the war, and for "controlled establishments."

Thermit, Limited, 675, Commercial Road, London, E., inform us that the whole of the company's shares, which, in August, 1916, were sold by the Public Trustee to the Birmingham Metal and Munitions Company, Limited, have now been taken into their own holding by Nobel's Explosives Company, Limited, Glasgow, and under the new auspices the activities of Thermit, Limited, are being considerably extended. The company own many valuable patents connected with the engineering industry, and are enabled to execute certain classes of work by methods other than those usually adopted. The company have at their disposal a highly-trained staff of chemists and engineers, and are specialising in the manufacture of high-grade metals and alloys in connection with munitions of war; also welding in all its branches by up-to-date methods, and engineering repairs generally. The principle of the Thermit reaction is no doubt familiar to most of our readers, but the success of the process demands a good deal of practical experience based on scientific knowledge. The company is wholly British, to the entire elimination of all enemy alien interests, and the trade and country generally have the satisfaction of knowing that all business done with this company is assisting British trade and interests to the fullest possible extent.

Holcroft's Steel Foundry Company, Limited, was registered in May, 1915, to take over and develop the Bilston Works of Messrs. Holcroft, which were acquired by the late Mr. Thos. Holcroft in 1848 from the Bilston Foundry and Engineering Works. In the early days Mr. Holcroft executed some very important engineering contracts, amongst such being a complete set of pumping plant for the Birmingham Corporation. For some years, however, operations have been confined to foundry work, the speciality being high-class iron castings, as also a slight tonnage of crucible steel castings. When the new company entered into possession it was decided to devote the works entirely to the production of steel castings, and to this end an experimental plant, consisting of a 10-cwt. Stock converter was installed. At this period the directors of the company were Messrs. G. Sankey, F. Sankey, G. Hatton (managing director of the Round Oak Works), and Mr. H. Hatton. In January of this year Messrs. Fassotte and Petteril, both gentlemen having had a very extensive experience of Belgian foundry practice, joined the board, and the Government's approval was obtained, with as little delay as possible, to carry out important extensions. In the meantime steps were taken to get the utmost out of the experimental plant, and with a considerable amount of success, for the output, which six months previously had been 50 tons per month, was in June of this year 80 tons.

The new board, it will be noted, is a happy combination of British and Belgian practice, and a leavening of Belgian workmen has also been introduced. It must, however, be distinctly understood that it is not proposed to develop on Belgian lines, but rather to obtain a combination of the best practice of both nations. The somewhat unique programme of the company, however, is possibly of Belgian inception, for it is certainly unusual in this country to decide upon a strictly limited maximum output, which is precisely what the Holcroft's Steel Foundry Company have agreed upon, it having been determined that the maximum output shall never exceed 400 tons per month. The company will devote themselves to the production of very high-class steel castings, and Mr. Fassotte (managing director) fixes the figure stated as a point beyond which they cannot go, and still exercise the close supervision which is so essential in steel foundry practice. The works generally are at present in a state of transition, for it was not till February of this year that a start was made with the new plant, and during the carrying out of this work the output of the old plant had to be maintained. As already stated, it was more than doubled. It is proposed to put down two 50-cwt. electric furnaces. Of these, the first (built by the Electro Metals Company) was started up last month. Recently the company have acquired the works and business of Messrs. John Hickman & Son, Great Western Iron Foundry, which adjoin the Baldwin Street side of the steel foundry. For a generation past this foundry has had a very high reputation for the quality of the castings produced, although the plant is now of a somewhat antiquated nature. The new owners are retaining the old management, and the works are to be entirely remodelled and laid down for producing castings of special irons.

In our July issue reference was made to the recipients of the Order of the British Empire, and the scant recognition of the foundry. We have since had our attention drawn to the fact that Mr. John T. Goodwin, another of the recipients of the M.B.E. decoration, is connected with the foundry. Mr. Goodwin was born at Ripley, and his family has been connected with the Butterley Company for upwards of a century. It was his great-uncle, George Goodwin, who was manager at Butterley during the Pentrich revolution in 1817, his father following him in that position. For some time Mr. Goodwin was at Butterley, where he served his time, later becoming assistant engineer at the blast furnaces of the Holwell Iron Company. He took charge of a section of the new foundry plant, laying out the same and erecting the buildings, etc. From Holwell he went to Messrs. Cochrane, of Middlesbrough, as works manager, having charge there of 1,500 men. Later he went to Sheepbridge to take the position of general manager of the foundry department, which has been completely reorganised. In the early part of the war the Sheepbridge Company were asked by the Admiralty to finish completely machined large cast-iron practice shot, and in 15 weeks from signing the contract they were able to turn out the first shot. Within the year they exceeded their contract output and received in consequence congratulations from the Admiralty. Of this class of ordnance the firm has made over 5,000 tons. The battleship "Queen Elizabeth's" first practice shots from her 15-in. guns were made at Sheepbridge. The Ministry in 1915 and 1916 desired a considerable amount of research work in connection with certain shells, and a great amount of this work was done by Mr. Goodwin. The firm are still manufacturing all kinds of munitions to the amount of 5,000 pieces per week, and up to date have made something like 8,000 tons of munitions of war. Mr. Goodwin is a lieutenant of the Derbyshire Motor Volunteer Corps. He is consulting engineer for the Tata Company, Limited, London and Bombay, for their new pipe foundry plant, the whole of which will cost 1½ millions.

Iron and Steel Scrap.

In accordance with an order issued last month by the Minister of Munitions, every person owning any iron or steel scrap, whether in the form of metal, machinery, plant or constructional steel or iron work, must sell and transfer such scrap whenever required by the Controller of Salvage and Stores, Ministry of Munitions. If any doubt arises as to whether any material is iron scrap or steel scrap for the purposes of the order, the decision of the Controller is final.

If any person does not, within thirty days of receiving instructions from the Controller, comply with the terms of such requirement, the material may be sold and transferred by the Controller, and the persons interested will be entitled to receive the price realised (after deducting the costs and expenses of and incidental to realisation and removal).

Everyone having in his possession any scrap sold by the Controller must give all reasonable facilities for the removal of such material, and for that purpose must place at the disposal of the Minister of Munitions labour and plant as required.

All persons owning or having in their possession or under their control any iron scrap or steel scrap must furnish to the Controller such returns as required.

All applications under the order should be made to the Controller of Salvage and Stores, Ministry of Munitions, Whitehall Place, S.W.1, and marked "Iron and Steel Scrap." The order is cited as "The Iron and Steel Scrap Disposal Order, 1918."

Cast-Iron Scrap.

The war material to which Regulation 30A of the Defence of the Realm Regulations applies will in future include cast-iron scrap, the order being cited as the Cast-Iron Scrap Order, 1918.

The General Permit of November 1, 1916, does not authorise any offer for sale or purchase or any sale or purchase of ingot mould scrap except direct to a steel maker or to a recognised scrap merchant for sale direct to a steel maker.

This permit does not authorise any offer for sale or purchase or any sale or purchase of any material coming within the Railway Materials (Second-hand) Order, 1916, without a special permit granted under that order.

Maximum Prices above referred to for Cast-Iron Scrap.

	Per ton. £ s. d.
(*a*) Heavy ordinary cast iron scrap, broken into pieces over 1½ cwt. each, but not exceeding 10 cwt. each ..	4 15 0
(*b*) Heavy machinery cast iron scrap, broken into pieces over 1½ cwt. each, but not exceeding 10 cwt. each	5 0 0
(*c*) Cold blast cast iron scrap, broken into pieces over 1½ cwt. each, but not exceeding 10 cwt. each	6 15 0
(*d*) Ingot mould scrap, unbroken	6 0 0
(*e*) Ingot mould scrap, broken into pieces over 5 cwt., but not exceeding 2 tons each	6 5 0
(*f*) Ingot mould scrap, broken into pieces over 1½ cwt. each, but not exceeding 5 cwt. each	6 10 0
(*g*) Extra for breaking any of the above into pieces not exceeding 1½ cwt. each...	0 5 0
(*h*) Cast iron railway chairs, whole or broken, sold for re-melting	5 0 0
(*i*) Heavy cast iron lumps, not exceeding 2 tons each..	4 12 6
(*j*) Light cast iron scrap	4 5 0
(*k*) Burnt cast iron scrap, broken ready for cupola ..	3 10 0
(*l*) Burnt cast iron fire bars	4 0 0
(*m*) Cast iron turnings and borings sold for use in the manufacture of iron and steel	3 5 0

To all the above prices for cast-iron scrap a sum not exceeding 2½ per cent. may be added in the case of sales by recognised scrap merchants. With the exception of the prices of cast-iron railway chairs and cast-iron turnings and borings, a sum not exceeding 10s. per ton to cover inwards carriage and handling may also be added by recognised scrap merchants in the case of sales from yards used as scrap yards at August 20, 1918. All the above prices are free on rail or free in barge at the nearest convenient siding or wharf to the place where the scrap lies at the time of sale.

Deaths.

Mr. J. H. Robinson, of the East London and Globe Foundries Company, died recently at the age of sixty-nine years.

The death is announced of Dr. Edgar Marburg, secretary and treasurer of the American Society for Testing Materials.

Mr. W. D. Ward, fourth son of the late Mr. John Ward, shipbuilder, Dumbarton, has been accidentally killed at Kimberley.

Mr. A. G. Bessemer, who has died at Ascot, aged seventy-eight, was the last surviving son of the late Sir Henry Bessemer.

The death took place recently, at the age of 66 years, of Mr. H. J. Pryce, formerly locomotive superintendent of the North London Railway.

Mr. F. Garrett, of Richard Garrett & Sons, Limited, agricultural engineers, Leiston Works, Leiston, Suffolk, has died at the age of 74 years.

Major E. W. Longden, of Meadow Bank Avenue, Sheffield, died on August 21. When war broke out he was works' manager to Peter Stubs, Limited.

After a lengthy illness, the death has occurred at his residence, The Peth, Durham, of Mr. Henry Jepson, who was a well-known engineer. He was 60 years of age.

Mr. J. Jackson died at East Kirklands, Hamilton, on August 20. The deceased gentleman was a director of Jackson, Elphick & Company, Limited, iron-founders, Larkhall.

The death took place last month of Mr. R. H. N. Sellar, chief partner of Messrs. George Sellar & Son, agricultural implement makers, Huntly and Alloa, at the age of 58 years.

The death took place at Barnes, London, S.W., recently, at the age of 69 years, of Mr. Joseph H. Robinson, of the East London and Globe Foundries, High Street, Bromley-by-Bow, E.

Mr. J. Wooldridge, of Stourbridge, who has died at the age of 60 years, was a partner in the firm of Messrs. John Wooldridge & Sons, spade and shovel manufacturers, Stourbridge.

The death has occurred at his residence, King's Lynn, of Mr. C. Tipple, one of the founders of the firm of William and Charles Tipple, and chairman of W. and C. Tipple, Limited, iron and steel merchants, Canning Town. The deceased was 75 years of age.

The death occurred on August 22, in a nursing home in Glasgow, of Mr. G. Thomson, naval architect with the firm of David and William Henderson & Company, Limited, shipbuilders and engineers, Partick. Mr. Thomson, who had been ill for a few months, was 68 years of age.

The death is announced of Mr. J. Boyd, Dunclutha, Bothwell, in his 81st year. Mr. Boyd was founder of the business of J. and T. Boyd, Limited, Shettleston Ironworks, in which he took an active part until a few years ago, and of which his eldest son, Major James Boyd, is a director. He was a Justice of the Peace for the county of Lanark.

The death took place at Codsall, on August 19, of Mr. Isaac Bradley, late of the firm of Thomas & Isaac Bradley, Limited, Capponfield Furnaces, Bilston. Mr. Bradley, who was eighty-five years of age, had been associated all his life with the South Staffordshire iron trade, and was, until his retirement in July of last year, a familiar figure on the Birmingham Exchange.

We regret to announce the death of Sir George Benjamin Hingley, Bart., which occurred at his residence, High Park, Droitwich, Worcestershire, on Monday night, at the age of sixty-eight years. The death of the famous baronet removes from our midst one of the leading iron and coalmasters of the Midlands. He was chairman of the Harts Hill Iron Company, Limited, Lloyd's British Testing Company, Limited, and N. Hingley & Sons, Limited.

Major B. Hopkinson, Professor of Mechanism and Applied Mechanics at Cambridge University, who for the past two years has held the position of Deputy Assistant Director at the Air Ministry, has been killed in a flying accident near London. Professor Hopkinson was the eldest son of the late Dr. John Hopkinson, F.R.S., and nephew of Sir Alfred Hopkinson, formerly Principal of Owens College and afterwards Vice-Chancellor of Manchester University. On his father's death in 1898 he started business as a consulting engineer in partnership with his brother, Mr. Charles Hopkinson, and Mr. E. Talbot. He was appointed Professor of Mechanism and Applied Mechanics at Cambridge in 1903, and in 1914 held a Professorial Fellowship at King's College.

Applications for Patents.

The names of communicators are printed in Italic type. A new number will be given when the Complete Specification is accepted.

Adaptable Moulding Machine Company and O'Keefe, W. M. Foundry moulding machines. 13,759. August 23

Alexander, H., Vint, W. T., and Imbery, A. Electrical device for automatically indicating correct temperature of electrically-heated steel before quenching to obtain correct hardening thereof. 13,698. August 22.

Allin, G. E. Furnaces for heating articles or pieces. 12,304. July 29.

Blackwell, H. A. Manufacture and application of ferro-tungsten. 12,363. July 30.

Blackwell, H. A. Manufacture of ferro-titanium. 12,364. July 30.

Booth, W. N. Furnaces, etc. 12,337. July 29.

British Thomson-Houston Company (*General Electric Company*. Metals and their manufacture. 11805. July 19.

Eyton, A. T. Means for producing continuous cast-metal wire. 11,522. July 13.

Fairweather, W. C. (*Lake*). Apparatus for making metal castings. 11843. July 19.

General Electric Company. Metals and their manufacture. 11805. July 18.

Hadfield, Sir R. A. Manufacture of low carbon ferro-manganese. 11,198. July 8.

Hadfield, Sir R. A. Manufacture of alloy steel. 12,332 July 29.

Hailwood, P. R. Highly refractory compositions for use in the building and repairs of acid-lined metallurgical furnaces, etc. 12,744. August 6.

Knowles, J. A. Feeder heads for ingot moulds. 12,624 August 2.

Lake, S. Apparatus for making metal castings. 11843. July 19.

Mooney, D. J. Treating steel for aircraft. 11,148. July 8.

Mooney, D. J. Metal construction of aircraft. 11,149 July 8.

Muirhead, W. Chilled iron rolls, etc. 11,366. July 11.

Naish, W. A. Rolling metals and alloys. 13,149. August 13.

O'Gorman, M., & Thomas, G. H. Indicating condition of steel etc., under heat treatment. 11,002. July 4.

O'Gorman, M., & Thomas, G. H. Method of indicating condition of steel, etc., under heat treatment. 11,003. July 4.

Pittevil, A. G. C. Welding different metals to form composite ingot. 12,583. August 1.

Player, E. Means for making foundry cores, moulds, etc. 11,435. July 12

Pope, P. C., & Thomas, G. H. Indicating condition of steel, etc., magnetisable metal under heat treatment. 11,004. July 4.

Richards, J. W., and *Shimer, P. W.* Case hardening metal 11901. July 20.

Rondelli, T. Electric furnaces. 13,024. August 10.

Robinson & Son, T. Sand-blasting metal castings. 12,301.

Rouvier, A. F. E. Method of uniting aluminium or aluminium alloy members to other metal members. 11,249 July 9.

Simon-Carves, Limited, & Brown, J. H. Crucible and melting-pot furnaces. 10,893. July 3. July 29.

South Durham Steel & Iron Company and Williams, T. Chequer bricks for regenerator chambers of furnaces, etc. 12,978. August 9.

Smeeton-Wright Furnaces, Fletcher, J. E., and Wright, T. Recuperators for furnaces. 12,582. August 1.

Smeeton-Wright Furnaces, Fletcher, J. E., and Wright, T. Gas-fired furnaces. 12,599. August 1.

Stabilimenti Biak—Ing. A. Pouchain. Light alloy for parts subjected to high temperatures. 11,946. July 22. (Italy, March 2.)

Stabilimenti Biak—Ing. A. Pouchain. Manufacture of aluminium alloy. 11,947. July 22. (Italy, March 2.)

Sterling Metals, Ltd. Machines for making foundry cores, moulds, etc. 11,435. July 12.

Stokes, F. W. Pourer for centrifugal casting-machines. 13,060. August 12.

Sumitomo Chukosho Limited. Magnet steel, 10,834. July 3.

MOULDING MACHINES

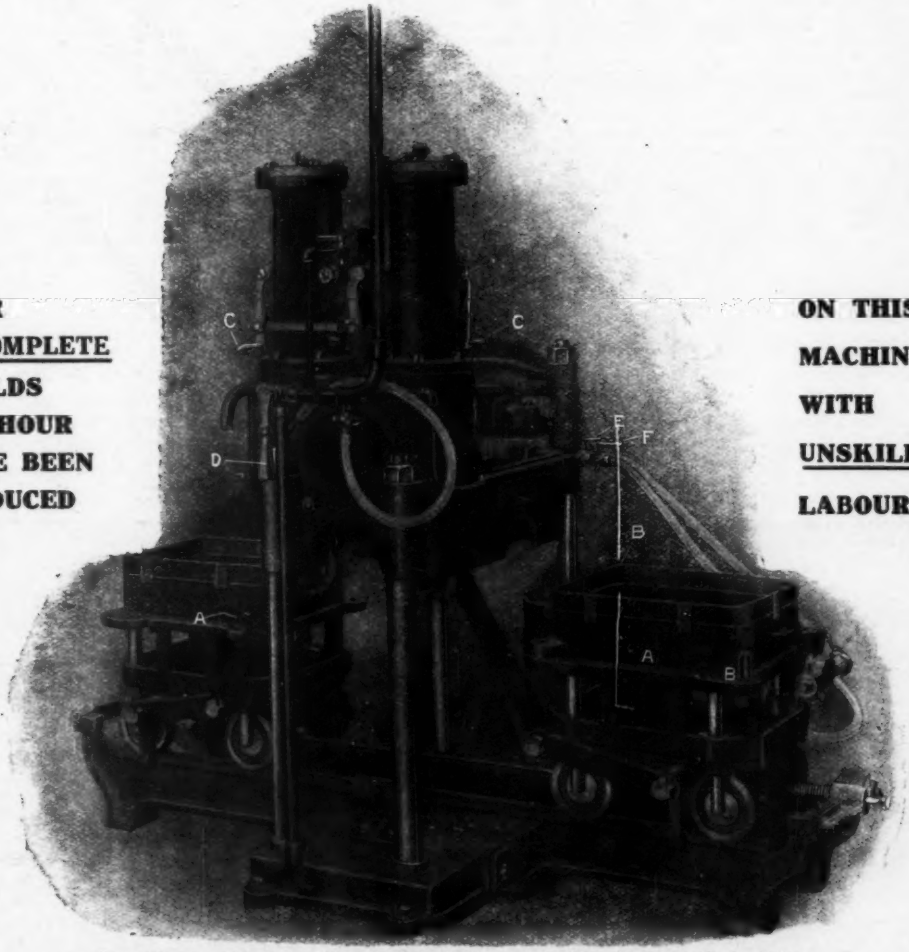
OF EVERY DESCRIPTION.

Pneumatic, Hydraulic, Jar Ramming, & Hand Power.

Type "A" Duplex Machine for Pneumatic Power.

Fitted with self-adjusting Rammer Head which accommodates itself to any varying depth of pattern.

OVER 50 COMPLETE MOULDS PER HOUR HAVE BEEN PRODUCED



ON THIS MACHINE WITH UNSKILLED LABOUR.

One of many that we have installed in various Munition Work Centres.

JAMES EVANS & CO., BRITANNIA WORKS, BLACKFRIARS, MANCHESTER.

Personal.

THE late Mr. W. Raby, of Didsbury, near Manchester, iron merchant, left £99,009.

THE late Mr. J. Cort, metal merchant, of Blackburn, left estate valued at £14,404 gross.

ESTATE of the gross value of £11,129 has been left by the late Mr. J. Monk, engineer, of Birmingham.

THE gross value of the estate of the late Mr. W. Ginman, ironfounder, of Plumstead, is £40,156.

THE gross value of the estate of the late Mr. P. Denny, engineer and shipbuilder, Dumbarton, is £51,458.

THE late Mr. J. R. Pickering, engineer, of Leeds, left estate valued at £20,157, including net personalty of £14,264.

THE late Mr. W. Hurst, for some years resident engineer for the London & North-Western Railway Company, left £8,937.

MR. H. G. WILLIAMS, secretary of the Machine Tool Association, is the Unionist candidate for the Universities Division.

THE late Mr. J. F. Wright, for many years head of J. and E. Wright, Limited, Birmingham, left estate valued at £114,675.

LORD EMMOTT has been elected chairman of the Committee inquiring into the question of decimal coinage on behalf of the Government.

THE late Mr. G. W. Willcocks, late Chief Engineering Inspector to the Local Government Board, left estate valued at £6,971 gross.

THE late Mr. G. Oldham, formerly connected with the Framwellgate Iron Foundry, left estate valued at £8,019, with net personalty £6,566.

CAPTAIN G. A. HERBERT, who has received the Croix de Guerre of the Legion of Honour, is a son of Mr. F. Herbert, of Stewarts & Lloyds, Limited.

MR. P. D. DONALD, who has been in the engineering department of the Clyde Navigation Trust for many years, has been appointed chief engineer.

MR. B. W WINDER, vice-chairman of Sir Joseph Jonas, Colver & Company, Limited, has been elected chairman of the company in place of Mr. (formerly Sir) Joseph Jonas.

MR. H. C. DESCH has been appointed to the Chair of Metallurgy in the Royal Technical College, Glasgow, rendered vacant by the resignation of Professor A. Campion.

MR. F. BIGGIN, who has been associated with the Brightside Foundry and Engineering Company, Limited, for 36 years, has been elected a director of the company.

MR. R. POLLOCK, O.B.E., Mr. A. Smith, M.B.E., and Mr. W. Donald, M.B.E., of Vickers, Limited, have been the recipients of presentations from the officials and men.

MESSRS. W. R. WILLIAMS & COMPANY, steel and tool manufacturers and merchants, of Sheffield, have removed their London premises to 23, Wilson Street, Finsbury, London, E.C.2.

MR. J. KNOWLES, assistant mill manager to Palmers Shipbuilding & Iron Company, Limited, has been the recipient of a presentation from the officials and workmen on the occasion of his marriage.

MR. J. BOURN, late shipyard manager for the Tyne Iron Shipbuilding Company, Limited, has been appointed shipyard manager for Earle's Shipbuilding & Engineering Company, Limited, of Hull.

MR. G. RENWICK (head of the firm of Fisher, Renwick & Company, Limited, shipbuilders, Newcastle) has been appointed by the President of the French Republic a Chevalier of the Legion of Honour.

THE EAST ANGLIAN ENGINEERING COMPANY, LIMITED, of the "Bull" Motor Works, Stowmarket, have appointed Mr. H. C. Waters as chief draughtsman and electrical engineer. He has served for a good many years on the motor draughting and design staff of Messrs. Crompton & Company, Limited, of Chelmsford, and is well known by both the staff and workmen of that firm

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SEND US YOUR ENQUIRIES FOR

are always successful in the struggle for the Mastery of the Air

Ventilation of Ships, Buildings and Mines, Induced Draught on Boilers, Dust Removal, High Pressure Fans for Forge Fires and Cupolas, Air Washers for Cooling and Purifying the Air, Fans for Removing Fumes or Steam, Steam Heater Units for Heating Factories and Workshops.

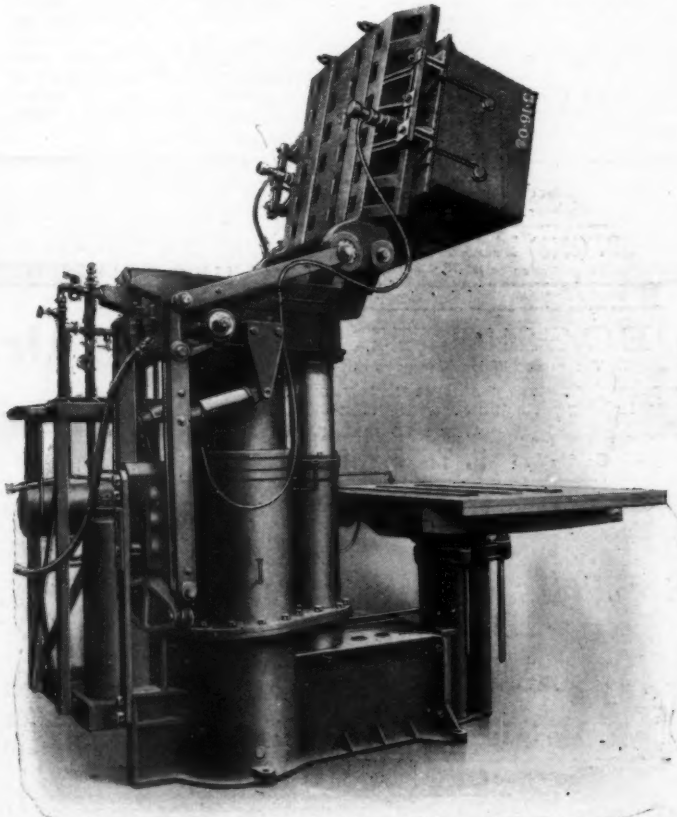
Davidson & Co., Limited, *Sirocco Works,* BELFAST.

MACNAB & Co.,

56/8, Eagle Street, Southampton Row, LONDON, W.C.1.

Tabor Combination Shockless Jar Ramming Power Roll-over and Pattern Drawing Moulding Machine.

Suitable for the most economical production of any repetition work from the smallest up to a load of 12,000 lbs. at 100 lbs. air pressure, covered by a range of five machines.



Mould having been rammed, box and pattern in act of being rolled over on to levelling table on other side of machine.

Jar rams the box in less than one minute.

Rolls the mould over, draws and raps the pattern.

Rolls the pattern back ready for the next box.

COMPLETE MECHANICAL OPERATIONS OF THE MACHINE NOT EXCEEDING FOUR MINUTES.

New Companies.

Coventry Munitions, Limited.—Capital £1,000 in £1 shares.

Metallurgical Foundries, Limited.—Capital £5,000 in £1 shares.

Hex Nut Machine Company, Limited.—Capital £5,000 in £1 shares.

Airton Engineering Company, Limited.—Capital £5,000 in £1 shares.

Great Eastern Metal Works, Limited.—Capital £10,000 in £1 shares.

Brown Bayley's Steel Works, Limited.—Capital £800,000 in £5 shares (100,000 pref.).

Patent Machinery Company, Limited.—Capital £500 in £1 shares. J. H. Woodington is permanent director.

Lancaster, Sons & Silcock, Limited.—Capital £5,000 in £1 shares, to carry on the business of engineers.

Metal Manufacturers, Limited.—Capital £10,000 in £1 shares. Registered office :—Thanet House, Strand, W.C.

Charles Winn & Company, Limited.—Capital £50,000 in £1 shares, to carry on the business of manufacturers of fittings.

Broad, Salmon & Company, Limited.—Capital £2,000 in £1 shares, to carry on the business of general engineers, brassfounders, etc.

Promper, Limited.—Capital £5,000 in £1 shares (1,500 10 per cent. cumulative preference), to carry on the business of engineers.

Radnor Manufacturing Company, Limited.—Capital £2,000 in £1 shares, to carry on the business of iron, brass and metal founders, etc.

Albion Iron Company (London, 1918), Limited.—Capital £5,000 in 300 8 per cent. preference shares of £10 and 2,000 ordinary shares of £1.

John Blyde, Limited.—Capital £5,000 in £1 shares, to carry on the business of cutlery, edge tools, file and steel manufacturers and merchants, etc.

Henry Robb, Limited.—Capital £30,000 in £1 shares to carry on the business of shipbuilders and engineers. Registered office : 18, Bernard Street, Leith.

Dunn, Davies & Whitner, Limited.—Capital, £20,000 in £1 shares, to carry on the business of engineers. Registered office :—92, Cannon Street, E.C.

H. F. A. Engineering Company, Limited.—Capital £2,000 in £1 shares, to take over the existing business. Registered office : 25, Warren Street, Islington.

E. M. Kelley, Limited.—Capital £5,000 in £1 shares, to carry on the business of lock manufacturers. Registered office : Wednesfield Road, Willenhall.

H. J. Brewster and Company, Limited.—Capital £15,000 in £1 shares, to take over the existing business of engineers. Registered office : 11, Queen Victoria Street, London, E.C.

Still the Premier

FURNACE MAKERS FOR MELTING, ANNEALING, HARDENING, &c. AND HEAT TREATMENT OF METALS.

OVEN FURNACES, gas, oil or solid-fuel fired. Fitted with Monometer Automatic Heat Controller.

CRUCIBLE and NON-CRUCIBLE MELTING FURNACES, gas, oil or solid-fuel fired. Tilting and Stationary Type, for STEEL, Iron, Copper, Gunmetal, Brass and all non-ferrous and ferrous metals.

HIGH SPEED STEEL FURNACE. Twin-chambered, gas or oil-fired. Even heat throughout chambers.

HEAT CONTROLLED FURNACES, for melting aluminium, lead, tin, antimony and all white metals.

DE-TINNING FURNACES.

WIRE TINNING FURNACES.

CABLE COVERING FURNACES.

OPEN-HEARTH FURNACES.

DIE-CASTING MACHINES, for casting bearings, &c.

BLOWERS, COMPRESSORS, FANS, Etc.

MONOMETER MANUFACTURING CO. (1918) Ltd., Whitehouse St., ASTON, BIRMINGHAM.

Chairman : H. J. THOMAS. *Managing Director and Engineer :* I. HALL, M.I.Mech.E., M.I.S.I. and I.M.

LEGGE'S IRON CEMENT.

The most efficient for general Engineering and Foundry Work.

It repairs permanently and effectively makes good all defects in Castings, leaking parts and connections in Steam, Water, Gas and Air, etc.

WRITE TO MANUFACTURERS—

16, South Castle St., **F. THOMPSON LEGGE & CO.** LIVERPOOL.

FERRO-VANADIUM. * * * * **FERRO-TITANIUM.**

SILICO-MANGANESE { **23/30** % Silicon. **65/70** % Manganese and **1** %, **2** %, **3** %, Carbon Maximum.

FERRO-SILICON Containing **25** %, **50** %, **75** % Silicon.

FERRO-CHROME **65/70** % Cr. & **1** % up to **8/10** % Carbon Maximum.

MAGNESIUM METAL **99** %. *In Sticks and Powder and Magnesium Copper.*

WE SUPPLY ALL CLASSES OF MINERALS, METALS AND METALLIC ALLOYS.

EVERITT & CO., 40, CHAPEL ST., LIVERPOOL.

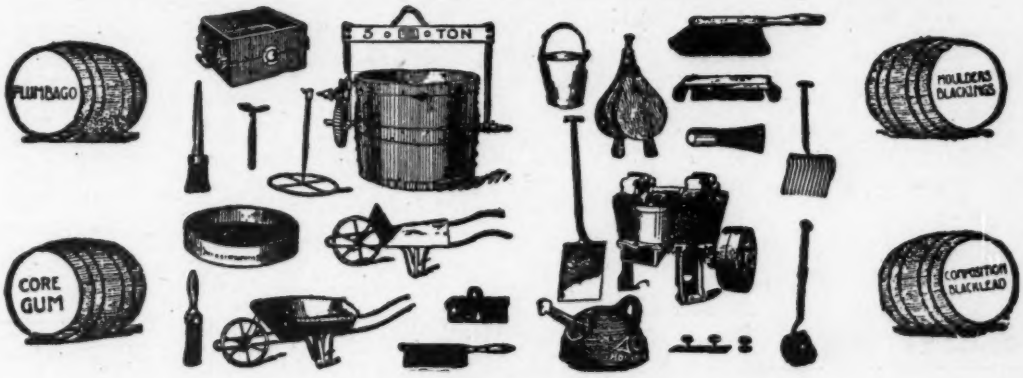
Telegrams : "PERSISTENT." Telephone No. 1134 (3 lines).

Telegrams: "Durrans, Penistone." Telephone: 21, Penistone

Established 1863.

JAS. DURRANS & SONS,

Phœnix Works, Penistone, Near Sheffield.



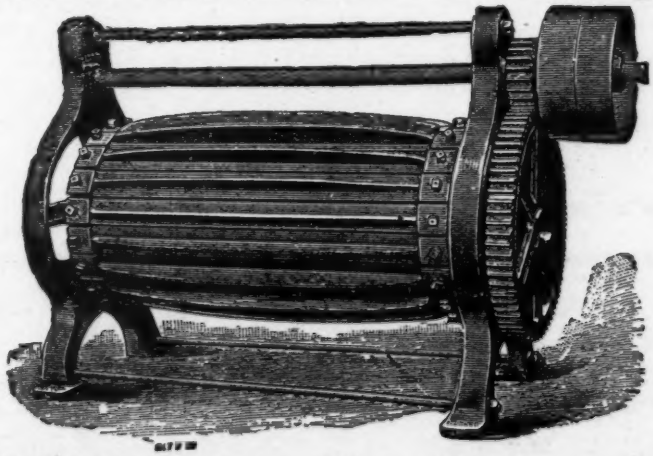
Manufacturers of all

FOUNDRY EQUIPMENTS

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Improved Foundry Rattler or Fettling Drum.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

The following testimonial explains itself :—

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD.

MONTHLY PRICE LIST.

The undermentioned prices, unless otherwise specified, are those obtaining at the commencement of the current month.

CONTROL PRICES.

Pig-Iron.

	£	s.	d.
West Coast hematite, mixed Nos. 1, 2 and 3	6	7	6
Special under 0.03 P. & S.	6	15	6
" " 0.02 "	7	0	0
East Coast hematite, mixed Nos. 1, 2 and 3	6	2	6
Special under 0.04 P. & S.	6	7	6
Special under 0.03 P. & S.	6	15	6
" " 0.02 "	7	0	0
Scotch hematite, mixed Nos. 1, 2 and 3	6	2	6
Special under 0.03 P. & S.	7	10	0
Welsh hematite, mixed Nos. 1, 2 and 3	6	2	6
Special under 0.03 P. & S.	6	15	6
" " 0.02 "	7	0	0
HEMATITE—MALLEABLE— Refined—			
Refined Cupola Cast	8	0	0
Refined Cupola Cast to guaranteed analysis	8	5	0
Cast direct from Blast Furnaces—			
Small Pig-Iron, all grades	7	10	0
Medium Pig-Iron White to Grey mottled	7	5	0
Medium Pig-Iron, all other qualities	6	17	6
Large Pig-Iron, all grades	6	17	6
Lincolnshire, basic or foundry	4	17	6
Cleveland, No. 1	4	19	0
" other grades	4	15	0
" basic	5	0	0
Northamptonshire, forge	4	7	6
" fdy. numbers	89/0		94/0
" basic	4	17	6
Derbyshire, forge	4	10	0
" foundry numbers	92/6		96/6
Derby & Notts. basic.	4	17	6
Leicestershire & Notts., forge	4	10	0
" " foundry nos.	92/6		96/6
North Staffs, forge	4	15	0
" " foundry	4	17	6
" " basic	4	17	6
South Staffordshire—			
Part mine forge	5	0	0
" foundry	5	2	6
Common Staffordshire	4	15	0
All mine forge	5	15	0
" foundry	6	0	0
Warm air forge	7	5	0
" foundry	7	15	0
Lord Dudley's silicon	8	7	6
Cold blast	9	2	6
Basic	4	17	6
Scotch foundry and forge— Nos. 3, 4, and lower grades of Monkland, Dalmellington, Eglinton, and Govan	5	14	0
Nos. 3, 4, and lower grades of all other brands	5	15	6

No. 1 quality in all cases to be 5s. per ton above these prices.

All per ton net, f.o.t. makers' works. Mers. Com. 1½%

In all districts 1s. extra may be charged for Basic cast in chills.

High-Speed Tool Steel.

The maximum prices for high-speed tool steel have been fixed as follows:—

Finished bars, 14% Tung. 3s. 8d.

Finished bars, 18% Tung. 4s. 5d.

Per lb. basis. Extras as per authorised list. These prices are net delivered buyers' works.

The fixed prices for scrap which must be returned to steel makers' works are as follows:—

Millings and Turnings 8d.

Bar Ends 9d.

Both per lb. net delivered steel makers' works.

Ferro-Alloys

Net, Delivered Sheffield steel works.

	£	s.	d.
Ferro chrome: 4/6% carbon. Basis 60%, scale 10s. per unit Per ton		—	
Ferro-chrome: 6/8% carbon. Basis 60%, scale 10s. per unit. Per ton		—	
Ferro-chrome: 8/10% carbon. Basis 60% scale, 10s. per unit Per ton		—	
Ferro-chrome: Specially refined, guaranteed maximum 2% carbon broken to small pieces for use in best quality crucible steels. Basis 60%, scale 32s. per unit. Per ton		—	
Ferro-vanadium: 33/40% Va., per lb. of Va. contained in the alloy		—	
Ferro-silicon: 45/50%. Basis 50%, 5s. scale per unit Per ton		—	
Ferro-titanium: 23/25%, per lb. carbonless		—	
Ferro-molybdenum: 70/80% Mo. per pound of Mo. contained		—	
Ferro-phosphorus: 20/25%. Per ton		—	
Ferro-tungsten: 75% to 80% per lb. of metallic tungsten contained		—	
*Ferro-manganese 80%	26	10	0
" export		—	

* F.o.b. Liverpool.

Non-Ferrous Metals.

Copper.

	£	s.	d.	£	s.	d.
Standard, Cash	122	0	0	122	10	0
Three months	122	0	0	122	10	0
Electrolytic	137	0	0	133	0	0
Tough	135	0	0	131	0	0
Best selected	135	0	0	131	0	0

Tin.

Standard, Cash	347	0	0	348	0	0
" Three months	347	0	0	348	0	0
English Ingots	349	10	0		—	
Bars	350	10	0		—	
Refined		—			—	

Spelter.

American	54	0	0	50	0	0
Specials		—			—	
Hard	45	0	0	46	0	0
British	56	10	0	57	0	0

Lead.

Soft Foreign (net)	29	10	0	28	10	0
English		—			Nom.	

Antimony.

Regulus		—		85	0	0

Aluminium.

Virgin Metal 98/99% per ton — —

Phosphor Bronze.

INGOTS.	Per ton.
Alloy No. I. or II	—
III., IV. or V.	—
VI. or VII.	—
VIII.	—
XI.	—
Cast Strips and Ingots	—

CASTINGS.	Per lb.
I. or II.	—
III. IV. or V.	—
VI. or VII	—
VIII.	—
XI.	—
No. VII., Chill, Cast, Solid	—
" Cored Bars	—

Delivery 2 Cwt. free to any town.

10 per cent. Phosphor Copper .. £50 above price of best selected copper.

15 per cent. Phosphor Copper .. £70 above price B.S.

Phosphor Tin (5 per cent.) .. £30 above price of English Ingots.

(Phosphor-bronze prices supplied by CHARLES CLIFFORD AND SON, LIMITED, FAKELEY STREET MILLS, BIRMINGHAM).

***Chromium (Metallic).**

98/99% purity, per lb. — —

***Nickel.**

In cubes, 98/99% purity Per ton —

Nickel Silver. per lb.

Ingots for raising —

Ingots for Spoons and Forks —

" rolled to spoon size —

***Tungsten Metal Powder.**

96/98% purity per lb. —

***Molybdenum Metal.**

96/98% purity per lb. —

***Cobalt Metal.**

97% purity per lb. —

Quicksilver.

75 lb. bottle —

* Net, Delivered Sheffield Works.

Scrap Iron and Steel.

Cleveland.	s.	d.	s.	d.
Steel scrap, heavy melting	—		—	
Iron scrap cast (cupola metal)	—		—	
London (f.o.b.).				
Heavy steel			104	6
Light "			55	0
Heavy cast			110	0
Control Prices.				
Heavy Steel Melting Scrap	105	0	125	0
Steel Planings, Turnings and Borings			65	0
Steel Planings, Turnings and Borings mixed with Wrought Iron, &c.			50	0
Steel Scrap, all other Classes			95	0
Wrought Iron Scrap			125	0
Ditto, mixed with Steel			95	0
W.I. Planings, Turnings and Borings mixed with Steel, &c.			50	0

Per ton delivered Buyers' Works.

Cast-Iron Scrap.

	£	s.	d.
Hy. ord. brkn., between 1½ cwt. and 10 cwt.		4 15	0
Hy. machy., brkn., bet. 1½ cwt. and 10 cwt.		5 0	0
Cold blast, brkn., bet. 1½ cwt. and 10 cwt.		6 15	0
Ingot mould, unbroken		6 0	0
Ditto, brkn., bet. 5 cwt. and 2 tons	6	5	0
Ditto, between 1½ cwt. and 5 cwt.	6	10	0
Extra for breaking into pieces not exceeding 1½ cwt.		0 5	0
Railway chairs for re-melting		5 0	0
Heavy lumps, not above 2 tons		4 12	6
Light		4 5	0
Burnt, broken, ready for cupola		3 0	0
Burnt fire bars		4 0	0
Turnings and borings for iron and steel makers		3 5	0

Per ton f.o.r. or f.i.b. Scrap merchants' commission, 2½ per cent.; additional 10s. allowed, except for railway chairs and turnings and berings, to cover inwards carriage and handlings on sales from scrap yards.

Coke.

Middlesbrough.	s.	d.	s.	d.
Gas Coke	45	0	—	
Foundry	65	0	—	
Glasgow.				
Foundry Coke	—		47	0
Furnace Coke	37	0	—	
Gas Coke	—			
London.				
Welsh or Durham Foundry, d/d London Stations in truck	45	0	53	0
Ditto, d/d Birmingham Stations	44	0	48	0
Yorkshire, d/d London Stations, in truck	42	6	—	
Ditto, d/d Birmingham Stations	39	6		

CONTROL PRICES OF COKE.

	s.	d.
Durham and Northumberland blast furnace	33	0
" foundry	38	0
Yorkshire, Lancashire, Staffordshire, Notts., Derbyshire, Lincs., & Midland Counties blast furnace	32	0
South Wales blast furnace	37	6
" foundry	50	6
All per ton net. f.o.t. ovens.		
Cumberland blast furnace	37	0
d/d West Coast furnaces		

SITUATIONS VACANT AND WANTED.

PRACTICAL Foundry Manager, with engineering and metallurgical qualifications, capable of organising and managing on modern lines foundry for high-grade Iron and Bronze Castings; commercial experience; highest references; desires appointment immediately.—Address, Box 982, Offices of the FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.2.

MOULDERS wanted, used to light aluminium and brass castings, for Aero Engine work, for large Aircraft Factory in North-West London.—Apply, stating age, wages and experience, to Box E. M., c/o W. H. Smith & Son, 55, Fetter Lane, E.C.4. No one engaged on Government work or residing more than ten miles away need apply.

PRACTICAL FOUNDRY MANAGER desires appointment; very wide and varied experience (gray iron, malleable and brass), motor, textile and general light castings trade; expert moulding machines and metals; good commercial experience; sound organiser; highest references.—Address, Box 974, Offices of the FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.2.

PIG IRON and FOUNDRY MACHINES.—Agencies wanted for France after the War by Commercial Engineer Agent.—Please answer to DESHERCES ALBAN, 6, rue de l'Hôpital Angoulême, Charente, France.

FOR SALE AND WANTED.

FOR SALE.—Foundry Cupola by Green Keighley. 2ft. 9 in. diameter, used only few heats, wind belt, capacity about 30 cwts. per hour.—Address, Box 992, Offices of the FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.2.

DIE CASTINGS.—Wanted, practical, working Charge Hands, capable of taking control of Dies.—Apply, stating age, wages, and experience, to ROBERT W. COAN, 219, Goswell Road, London, E.C.1.

FOR SALE as a Going Concern, a small Freehold up-to-date self-contained and well-equipped Electric Steel Foundry, complete with Generating Plant, situate within 40 miles of London. Exceptional opportunity.—Apply. Box No. 990, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.2.

FOR SALE AND WANTED.—*Continued*

HEAVY RODS.—Nos. 0 to 3. Straight or in Coils. Apply W. PATTISON, Widnes.

CORE MAKING for IRON CASTINGS.—(1) Makers or suppliers of Notched Wire; (2) Makers or suppliers of effective Core Binders—Linseed Oil substitutes.—Address, Box 980, Offices of the FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.2.

WANTED, one second-hand 600-lb. Wright's lip-axis tilting furnace.—Send full particulars, conditions, date installed, etc., to Box 986, Offices of *The Foundry Trade Journal*, 165, Strand, London, W.C.

ROTARY TABLE SAND BLAST MACHINES, second-hand, required for urgent Government work. Diameter of table 70 ins.; capacity 20 tons iron castings per hour.—Send all particulars to Box 976, Offices of the FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.2.

NOTICE.

SOUTH-WESTERN POLYTECHNIC INSTITUTE,
MANRESA ROAD, CHELSEA, S.W.3.

Department of Chemistry and Metallurgy.

Head of Department: J. B. Coleman, A.R.C.S., F.I.C., F.C.S.

Lecturer in Metallurgy: W. A. Naish, A.R.S.M., A.I.M.M.

METALLURGY.

Day and Evening Courses commence on Sept. 23, 1918. In addition to the ordinary graded courses, instruction is given in Metallurgical Analysis, Engineering Metallurgy, Metallography, and Pyrometry. The work is suited to the requirements of Metallurgists, Assayers, Engineers, and Foundrymen. Special facilities are afforded for individual work in any other branch of Metallurgy, such as Fuel Examination, Mechanical Testing, Alloy Research Work, Heat Treatment, etc. A Special Course of Lectures will be arranged on "Foundry Practice."

For fees and further particulars apply to the Secretary (Room 65). Telephone: 899 Western.

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MINERALS. METALS. ALLOYS.
also
REFRACTORY MATERIALS and all requisites for the Engineering Trades.
Correspondence Invited.

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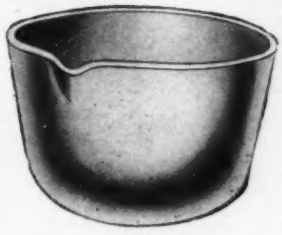
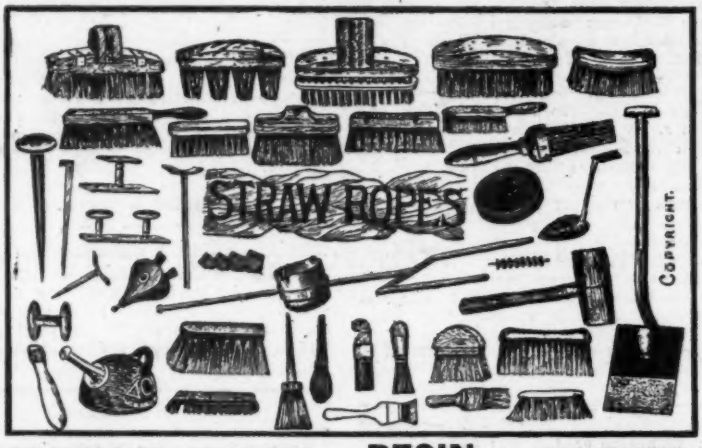

Pressed Steel
Foundry Ladles
Plain or Lipped.
Joseph Sankey & Sons, Ltd.,
Hadley Castle Works, **Wellington,** Shropshire.

Established 1890. Telegrams: Wm. Olsen, Hull.

CORE GUM. — **GLUTRIN.** — CORE OIL.

PARTING. — PLUMBAGO.



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METALLIC CEMENT. — **RESIN.** — GANISTER.

Motto—'The Right Articles at the Right Price.'

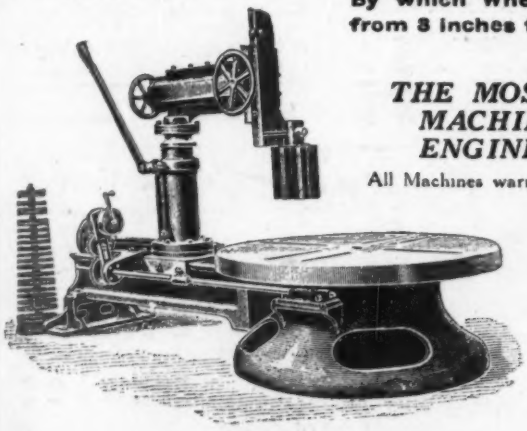
WILLIAM OLSEN, Ltd.,

Materials and Requisites for Ironwork, Brassfounders, &c.,

COGAN STREET, HULL.

WHITTAKER'S IMPROVED MOULDING MACHINE

By which Wheels or Pulleys of any description or size from 3 inches to upwards of 20 ft. diameter can be made,



THE MOST COMPLETE AND EFFICIENT MACHINE HITHERTO INTRODUCED TO ENGINEERS.

All Machines warranted to Mould with the greatest accuracy and precision.

GEARING WHEELS

Spur or Bevel, Straight Teeth and Double Helical Teeth Supplied to Consumers.

ROPE & BELT PULLEYS.

WM. WHITTAKER & SONS, LTD.,

SUN IRON WORKS, ***OLDHAM.***

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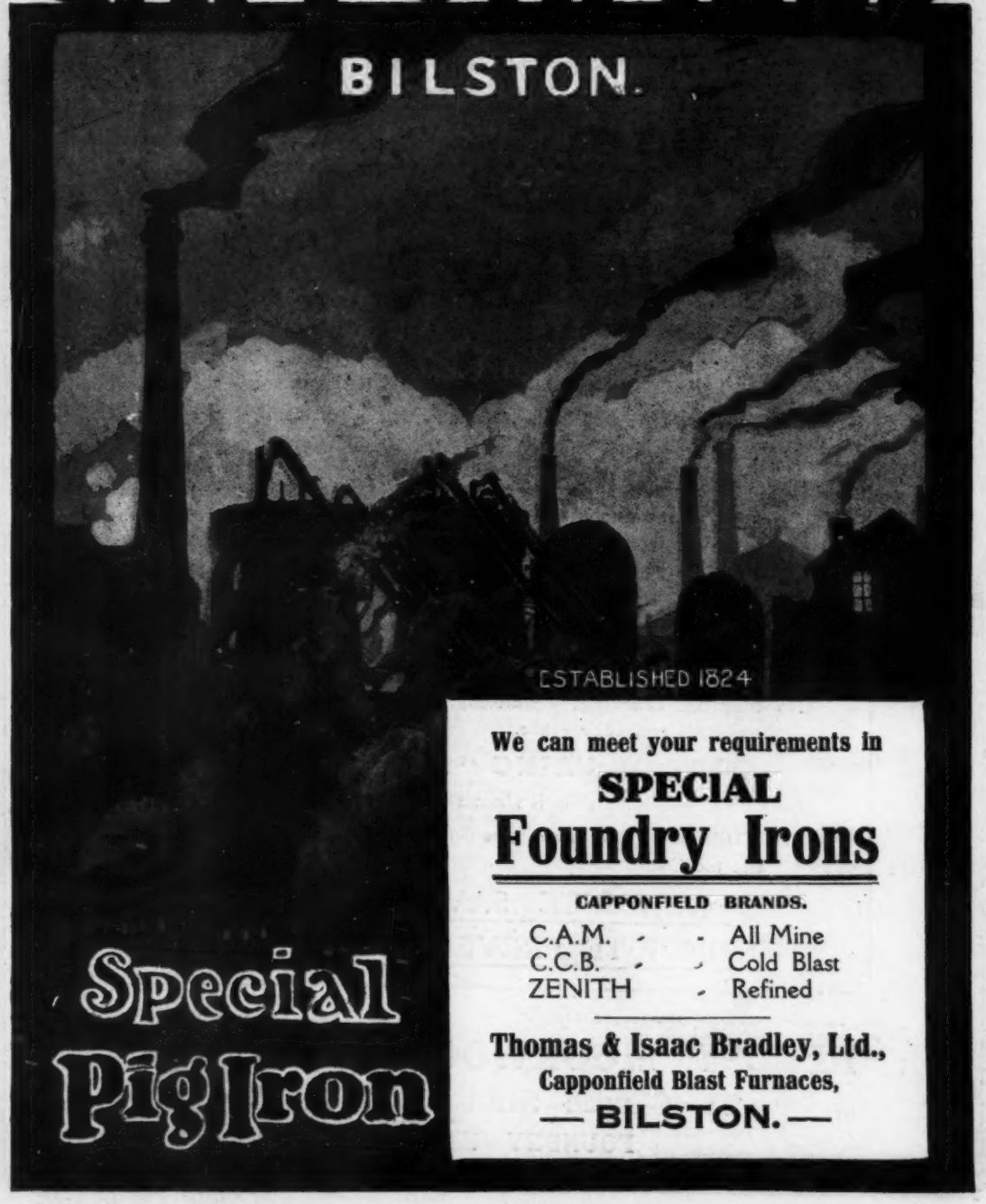

Special Pig Iron

We can meet your requirements in

SPECIAL

Foundry Irons

CAPPONFIELD BRANDS.

C.A.M.	All Mine
C.C.B.	Cold Blast
ZENITH	Refined

Thomas & Isaac Bradley, Ltd.,
Capponfield Blast Furnaces,
— BILSTON. —

"FOUNDRITE."

"FOUNDRYMEN have been seeking this material for years."

Supplied only in 40 gallon Casks. No bulk broken.

FOUNDRITE is another German speciality superseded and improved.

FOUNDRITE is **the** binding material for moulding sand and cores.

FOUNDRITE SUPERSEDES and makes unnecessary all classes of **CORE GUM, LINSEED OIL and all other BINDING material.**

FOUNDRITE will renew old and burned sand, making it usable over and over again.

FOUNDRITE makes **CORES** unbreakable and the use of **core irons** unnecessary.

FOUNDRITE leaves **CORES** perfectly porous and does **not shrink.**

FOUNDRITE has been **"found right"** for all **Sand binding** in the Foundry **for all purposes.**

FOUNDRITE is supplied in **LIQUID** form ready for use. Dilute with Water.

The porosity of the core is perfect, and cores so made do not shrink.

No blowing, cracking, crumbling, honeycombing, or loss of strength can take place.

COST OF USING "FOUNDRITE."

For ordinary work the price is about One Penny per gallon.

FOUNDRITE is used in all important Foundries in Great Britain and the Continent.

FOUNDRITE SAVES MONEY.

FOUNDRITE PREVENTS WASTERS.

Telegraphic Address—"MOROD, SHEFFIELD." **Telephone 4318.**

HEDLEY MOORWOOD & Co., Ltd.,

21, Church Street, SHEFFIELD.

FOUNDRY EXPERTS.

THE B&B Power Moulding Machine

FULL PARTICULARS FROM

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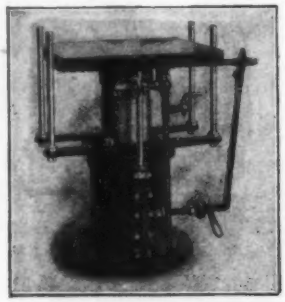
DERBY.

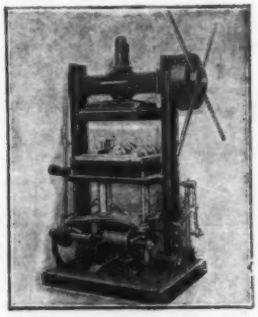
MAKERS OF THE CELEBRATED BLACKHEART MALLEABLE CASTINGS.

British Moulding Machines

And FOUNDRY EQUIPMENT.



TheJARR RAM (Pneumatic).
The Machine with a Perfect Lift.



The HEAD RAM.
Most powerful Hand Machine made.

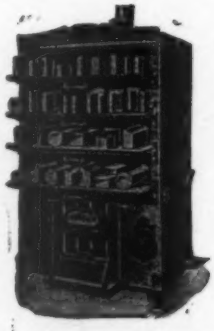
The HAND RAM.
Adjustable to any size Box.

The most efficient Machines, built to stand rough usage.

Write for Catalogue to—

Britannia Foundry Company,

COVENTRY, ENGLAND.



THE "PORTWAY"

PORTABLE CORE OVENS

For Gas or Fuel.

TESTIMONIAL.

From The Braintree Castings Co.,
Chapel Hill Foundries, Braintree, Essex.

Gentlemen,

We are very pleased with the Core Oven we recently purchased from you. We find it dries the cores quickly without burning them. It is very handy and economical to use and is altogether superior to other ovens of this type we have in use.

Will you please quote us your best price for four more like it,

Yours faithfully,
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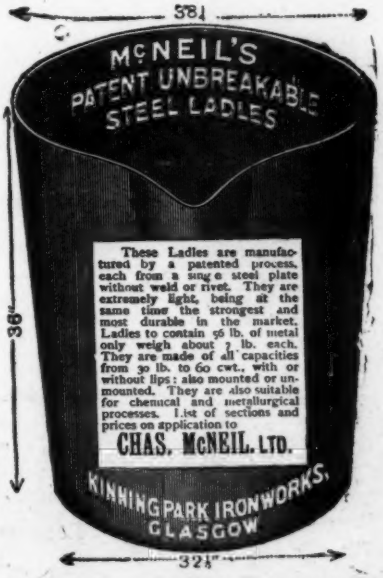
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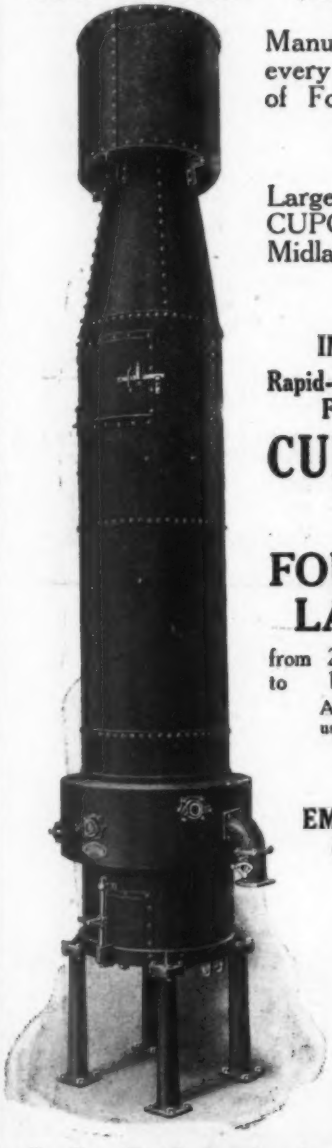

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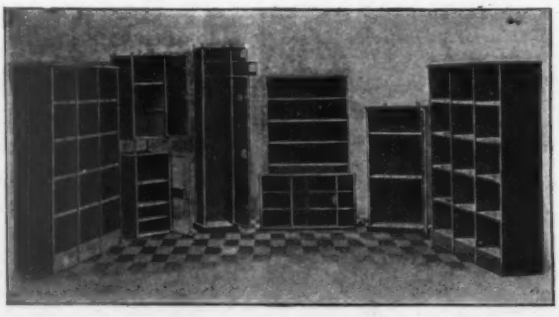

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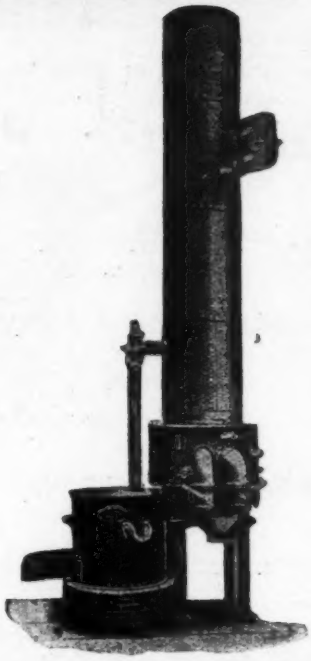

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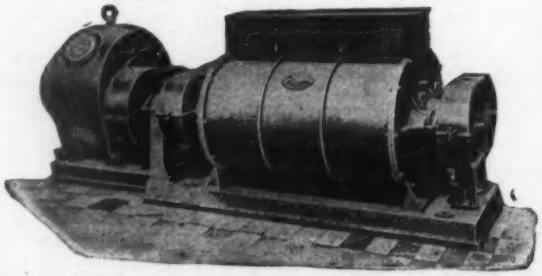

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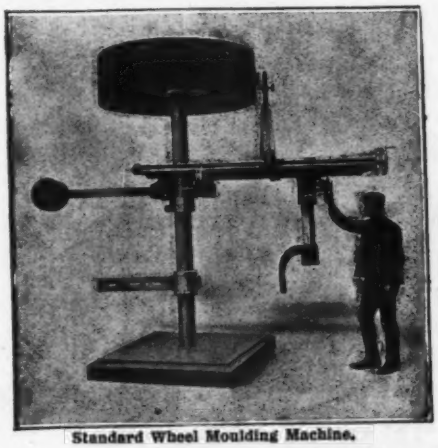

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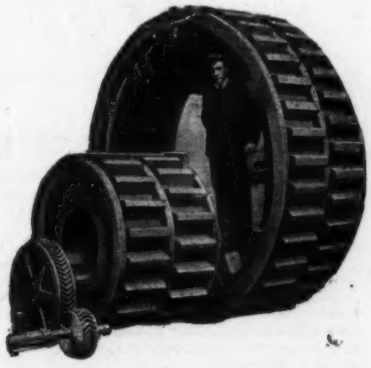

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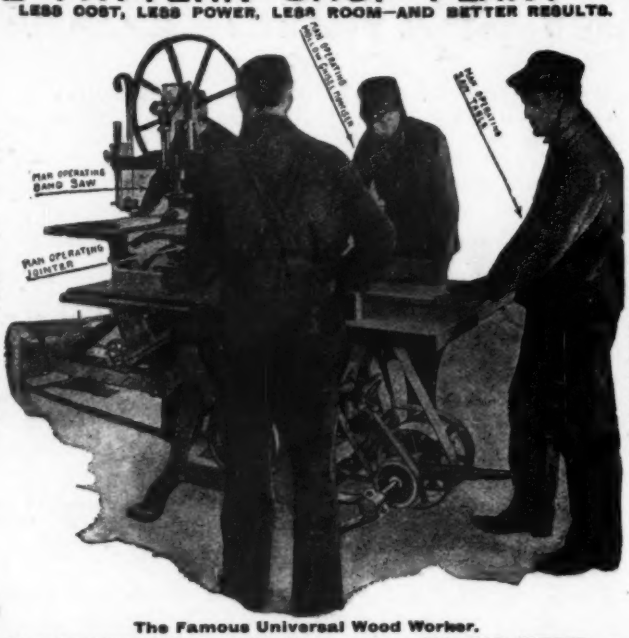

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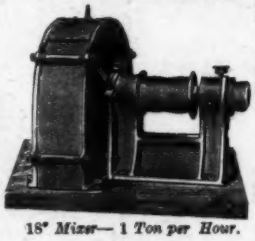

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